BIOLOGICAL SCIENCES

The biology major provides a unified curriculum for undergraduates enrolled in either the College of Agriculture and Life Sciences or the College of Arts and Sciences. Courses in biological sciences are integral to many disciplines and are basic requirements in many schools and colleges at Cornell.

Graduate study in the biological sciences is administered by 30 specialized fields within the Graduate School, as described in the Fields of Study catalog at www.gradschool.cornell.edu/?p=38.

ORGANIZATION

Many different departments participate in the biology major.

Student services are provided by the Office of Undergraduate Biology (OUB), www.biology.cornell.edu. Located in Stimson Hall, the professional and student advisors provide academic and career advising, as well as help undergraduates find research opportunities on campus. Advisors in the OUB also follow the progress of biology majors and work closely with faculty advisors. Additional services and resources of the Biology Center include tutoring, examination files, and extensive information on summer research opportunities and graduate programs. The center has comfortable areas for studying and relaxing.

The Shoals Marine Laboratory, a cooperative venture with the University of New Hampshire, is located on Appledore Island in the Gulf of Maine. Its base office in Stimson Hall provides academic advising for students interested in the marine sciences and administers the SEA Semester program for Cornell students pursuing studies at Woods Hole, Mass., or aboard the schooner *Robert C. Seamans* or brigantine *Corwith Cramer.*

DISTRIBUTION REQUIREMENT

In the College of Agriculture and Life Sciences, the Physical and Life Sciences distribution requirement is a minimum of 18 credits, including at least 6 credits of introductory biology satisfied by BIOG 1109–1110, 1105–1106, or 1101 and 1103 plus 1102 and 1104, or 1107–1108.

For Students in the College of Arts and Sciences, all biology ("BIO") courses can be used toward fulfillment of the biological sciences distribution requirement. Please see the Arts and Sciences "Distribution Requirements" section of this catalog for further details. The following courses are especially suitable for the distribution requirement because they have no prerequisite: BIOG 1101–1104, 1105–1106, 1107–1108, 1109–1110, 1700; BIOEE 1540, 2070; BIONB 1110; BIOPL 1120, 2400, 2410.

In the College of Human Ecology, the natural sciences distribution requirement is for at least 6 credits selected from BIOG 1109–1110, 1101 and 1103 plus 1102 and 1104, 1105–1106 or 1107–1108 or from specified courses in chemistry or physics.

Switching between BIOG 1109–1110 and either BIOG 1101–1104 or 1105–1106 at midyear may not be possible because of variation in presentation of topics. Students must receive permission of the instructor to switch sequences. Taking sequences in reverse order is strongly discouraged in BIOG 1101–1104 but allowed in BIOG 1105–1106.

USE OF ANIMALS IN THE BIOLOGICAL SCIENCES CURRICULUM: CORNELL UNIVERSITY

Students wishing to enroll in biology ("BIO") courses should know and understand the following criteria relative to the use of animals in the teaching program, as passed by the faculty of the Division of Biological Sciences in 1988, and reaffirmed in 1997:

1. "Live animals will be used for teaching in certain courses in the biological sciences. Some animals will require humane euthanasia after they have been used for teaching.
2. Courses bearing the "BIO" description conform to the rules for the care of such animals as outlined in *Guiding Principles in the Care and Use of Animals* (as approved by the Council of the American Physiological Society), the Guide for the Care and Use of Laboratory Animals (DHEW publication 86–23, revised 1996; see p. 7, *Courses of Study)*, the Animal Welfare Act, and the New York State Public Health Law. Within these regulations, and in keeping with the principle of Academic Freedom of the Faculty, the use of animals to aid in teaching any biological sciences discipline is at the discretion of the professor in charge.
3. Each course, as well as research projects, in which animals are used receives a formal review annually by the Cornell University Institutional Animal Care and Use Committee (IACUC).
4. Any concerns regarding the use of live animals in teaching should be addressed first to the faculty member responsible for that course. He or she is required to be in compliance with all applicable regulations and guidelines. Alternatively, students may choose to address their concerns to the director of the Cornell Center for Research Animal Resources, Dr. Michele Bailey, at 253–3523. The director may initiate discussion with the faculty member responsible for a particular course without involving the student if he or she would prefer to remain anonymous.
5. Enrollees in those courses in the biological sciences in which animal use is a component may, at the professor's discretion, be asked to sign copies of this statement (USE OF ANIMALS . . .) at the first meeting of the course."

ADVANCED PLACEMENT

For information on credit for advanced placement in biological sciences, see www.biology.cornell.edu/advising/ap.html.

THE MAJOR

The major of biological sciences is available to students enrolled in either the College of Agriculture and Life Sciences or the College of Arts and Sciences. The undergraduate program is coordinated for students in both colleges by the Office of Undergraduate Biology. By completion of the sophomore year, all students who intend to major in biological sciences must declare the major and a program of study through the Office of Undergraduate Biology, in 216 Stimson Hall.

Whenever possible, students should include the introductory biology, chemistry, and mathematics sequences in their freshman schedule and complete the organic chemistry lecture course in their sophomore year. Biology majors should regularly monitor their progress in the major, and should assess as realistically as possible the likelihood of achieving at a level that is consistent with their academic and personal goals. Weak performance in core courses, particularly after the freshman year, may indicate a need to reevaluate aptitude and genuine interest in the major. Students with questions, particularly with concerns about their ability to complete the major, are encouraged to consult with their biology advisor and to take advantage of the advising and counseling resources of the Office of Undergraduate Biology as well as those of the university and their college.

The requirements for the biological sciences major are listed below. Requirements 1–9 must be taken for a letter grade. Courses taken for the program of study should be taken for a letter grade unless the course is offered for S-U grades only or if the student's advisor grants permission.

1. **Introductory biology for majors** (one year): BIOG 1101 and 1103 plus 1102 and 1104, or 1105–1106. BIOG 1107–1108, offered during the eight-week Cornell summer session for 8 credits, also satisfies the introductory biology requirement for majors.
2. **General chemistry**: CHEM 2070–2080 or 2150. Students who, via advanced placement, take only CHEM 2080 or only 2150 should be aware that some professional and graduate schools require 8 credits of general chemistry. These students may wish to take both CHEM 2150 and 2080 or 2150 and

2160. Students may wish to consult with their faculty advisor or advisors in the Office of Undergraduate Biology for further clarification.

3. **College mathematics** (one year): one semester of calculus (MATH 1106, 1110, 1910, or their equivalent) plus one semester selected from the following:
   a. a second semester of calculus (MATH 1120, 1920, or their equivalents).
   b. a course in finite mathematics (MATH 1105).
   c. a course in statistics (BTRY 3010, MATH 1710, AEM 2100, ILR 2100, PSYCH 3500, PAM 2100, ECON 3190, ECON 3210, SOC 3010).
4. **Organic chemistry**: CHEM 1570 and 2510, or 3570–3580 and 2510, or 3570–3580 and 3010, or 3590–3600 and 2510, or 3590–3600 and 3010.
5. **Physics:** PHYS 1101–1102, 2207–2208,* or 1112–2213.* Those who take PHYS 1112–2213 are advised to complete PHYS 2214 as well.
6. **Genetics:** BIOGD 2810.
7. **Biochemistry:** BIOBM 3300, or 3310 and 3320, or 3330.
8. **Evolutionary biology:** BIOEE 2780 or BIOPL 4480. Note: BIOPL 2410 Botany is a prerequisite course to BIOPL 4480.
9. **A program of study** selected from the outline below.

Although not required for the biological sciences major, a course in statistics is recommended for all biology students. Students should consult their faculty advisors when choosing appropriate courses in statistics.

Note: Core courses cannot count toward the program of study requirements.

Programs of Study and Requirements

As noted in the list of requirements above, students accepted into the biological sciences major must choose a program of study. Whereas the core requirements of the biology curriculum provide the common foundation deemed essential for all biology majors, the role of the program of study is to provide either a concentration in a particular area of biology or, in the case of the general biology program of study, a survey of biology that is broad but not superficial. The program of study requirement can be met by taking 13 to 15 credit hours of courses chosen by the student in consultation with his or her biology advisor. Programs of study for particular subject areas are designed by faculty members specializing in the subject. Typically, the program of study consists of one or more courses that provide foundation in the subject and a list of optional courses from that area or related areas, many of which are at an advanced level (3000 or higher). Because biology is an experimental science, most programs of study require one or more laboratory courses. The laboratory requirement in some programs of study can be met by participation in the independent research course (BIOG 4990). The possible programs of study and their requirements are following:

1. ***Animal Physiology:*** BIOAP 3110 Introductory Animal Physiology, BIOAP 3160 Cellular Physiology, plus a minimum of 7 credit hours selected from the following lecture and laboratory courses, of which at least 4 credit hours must be a laboratory course.
   a. Lecture courses: BEE 4540 Physiological Engineering; ANSC 3000 Animal Reproduction and Development; ANSC 4100 Nutritional Physiology and Metabolism; ANSC 4270 Fundamentals of Endocrinology; BIOG 3050 Basic Immunology; BIOAP 2140 Biological Basis of Sex Differences; BIOAP 4580 Mammalian Physiology; BIOAP 4750 Mechanisms Underlying Mammalian Developmental Defects; BIOAP 4890 Mammalian Embryology; BIOBM 4070 Nature of Sensing and Response: Signal Transduction in Biological Systems; BIOBM 4370 Eukaryotic Cell Proliferation; BIOBM 4834 Molecular Aspects of Development; BIOGD 3850 Developmental Biology; BIOGD 4000 A Genomics Approach to Studying Life; BIOGD 4010 Genomic Analysis; BIOGD 6100 Genomes as Chromosomes; BIOGD 6120 Overview of Model Genetic Organisms; BIONB 3220 Hormones and Behavior; BIONB 3260 The Visual System; BIONB 4920 Sensory Function; NS 3310 Physiological and Biochemical Bases of Human Nutrition.
   b. Laboratory courses: BEE 4540 Physiological Engineering; ANSC 3010 Animal Reproduction and Development; BIOG 4010 Introduction to Scanning Microscopy; BIOG 4030 Transmission Electron Microscopy for Biologists; BIOAP 4130 Histology: The Biology of the Tissues; BIOAP 3190 Animal Physiology Laboratory; BIOAP 4160 Cellular Physiology and Genomics Laboratory; BIOBM 4400 Laboratory in Biochemistry and Molecular Biology; BIONB 4910 Principles of Neurophysiology.
2. ***Biochemistry:*** BIOBM 4400 Laboratory in Biochemistry and Molecular Biology; physical chemistry (CHEM 2870–2880 or 3890–3900 or 3890–2880); 6 credits of organic chemistry (CHEM 3570–3580 or CHEM 3590–3600); plus one of the following two alternatives. Students wanting to maximize their background in chemistry should take CHEM 3000 Quantitative Chemistry and CHEM 3010 Honors Experimental Chemistry I (Students who choose this option should not take CHEM 2510). Students wanting to gain further depth in biochemistry and related disciplines should take BIOBM 4320 Survey of Cell Biology and either CHEM 3000 Quantitative Chemistry or CHEM 2520 Elementary Experimental Organic Chemistry. Students choosing the first alternative are encouraged to take BIOBM 4320.

Notes:

- CHEM 2880 is designed for biologists. Five hours of biochemistry are recommended (3310 and 3320, or 3300 and 3340 or 3330 and 3340). Students interested in graduate work in biochemistry should take PHYS 2207–2208 and should consider taking CHEM 3890–3900 and its prerequisites. They should be sure to complete CHEM 2070–2080 or 2150–2160 during their freshman year.
- Biology majors in the College of Agriculture and Life Sciences who select the biochemistry program are allowed to take up to 61 credit hours in the endowed colleges because of the high number of required endowed courses for this program of study.

3. ***Computational Biology****:* Computation has become essential to biological research. Genomic databases, protein databanks, MRI images of the human brain, and remote sensing data on landscapes contain unprecedented amounts of detailed information that are transforming almost all of biology.

   Problems investigated by computational biologists include topics as diverse as the genetics of disease susceptibility; comparing entire genomes to reveal the evolutionary history of life; predicting the structure, motions, and interactions of proteins; designing new therapeutic drugs; modeling the complex signaling mechanisms within cells; predicting how ecosystems will respond to climate change; and designing recovery plans for endangered species. The computational biologist must have skills in mathematics, statistics, and the physical sciences as well as in biology. A key goal in training is to develop the ability to relate biological processes to computational models. Cornell faculty work primarily in four subareas of computational biology: biomolecular structure, bioinformatics and data mining, ecology and evolutionary biology, and statistical and computational methods for modeling biological systems. Specific topics of study include DNA databases, protein structure and function, computational neuroscience, biomechanics, population genetics, and management of natural and agricultural systems.

   Beyond core skills in mathematics, physical sciences, and biology, the computational biology program of study requires additional course work in mathematics and computer programming, a "bridging" course aimed at connecting biology to computation, and an advanced course where the theoretical/computational component of one aspect of biology is studied. Students should enroll in the more rigorous courses in the physical and mathematical sciences and may wish to take additional courses in these areas.

   Computational biology has applications as broad as biology itself. The problems of interest and the tools available to study them are constantly evolving, so students are encouraged to gain fundamental skills that will serve them throughout their careers. There is great, and increasing, demand for research scientists and technical personnel who can bring mathematical and computational skills to the study of biological problems. The program is also an excellent preparation for graduate study in any area of biology or computational biology.

Required Courses for Program of Study in Computational Biology

a. One course in computer programming (CS 1110, CS 1112, CS 1113, CS 1114) Introduction to Computer Programming, or BEE 1510, Introduction to Computer Programming.

b. One additional course in mathematics (MATH 2210 Linear Algebra; or MATH 2310 Linear Algebra with Applications; or MATH 2940 Linear Algebra for Engineers; or MATH 4200 Differential Equations and Dynamical Systems; or BTRY 4070 Principles of Probability and Statistics; or BTRY 4080 Theory of Probability; or BTRY 4210 Matrix Computation).

c. One of the following bridging courses, i.e., a course in mathematical modeling applied to biology

BIOEE 3620 Dynamic Models in Biology

BIOEE 4600 Theoretical Ecology

BIONB 3300 Introduction to Computational Neuroscience

BTRY 4820 Statistical Genomics

BTRY 4830 Quantitative Genomics

BTRY 4840 Computational Genomics

CS 4520 Introduction to Bioinformatics

NTRES 3100 Applied Population Ecology

NTRES 4110 Quantitative Ecology and Management of Fisheries Resources

d. One course from the following list of advanced courses, or an additional "bridging" course numbered 4000 or above:

BIOBM 6310 Protein Structure and Function

BIOGD 4810 Population Genetics

BIOGD 4840 Molecular Evolution

BIOGD 4870 Human Genomics

BIONB 4220 Modeling Behavioral Evolution

BIOPL 4400 Phylogenetic Systematics

BTRY 4070 Principles of Probability and Statistics

BTRY 4080 Theory of Probability

BTRY 4090 Theory of Statistics

BTRY 4790 Probabilistic Graphical Models (also CS 4782)

BTRY 6520 Computationally Intensive Statistical Inference

CS 2110 Object-Oriented Programming and Data Structures

CS 4210 Numerical Analysis and Differential Equations

CS 4220 Numerical Analysis: Linear and Non-Linear Problems

CS 6522 Biological Sequence Analysis

MATH 4200 Differential Equations and Dynamical Systems

NTRES 4120 Wildlife Population Analysis: Techniques and Models

NTRES 6700 Spatial Statistics

ORIE 3500 Engineering Probability and Statistics II

ORIE 3510 Introductory Engineering Stochastic Processes

Notes:

1. It is strongly recommended that students in this POS use PHYS 2207/2208 to satisfy the Core physics requirement.
2. It is strongly recommended that students complete the Core organic chemistry requirement using the CHEM 1570/2510 option, and that the time saved be used to take either CS 2110 or a second mathematics course from the list above.
3. MATH 2210 Linear Algebra, MATH 2310 Linear Algebra with Applications, or MATH 4200 Differential Equations and Dynamical Systems is recommended for bridging course BIOEE 4600.
4. One course may not be used to satisfy two different requirements simultaneously. For example, BTRY 4080 can be used to satisfy either requirement (2) or requirement (4), but not both.
5. Students who use BTRY 4080 to fulfill the additional mathematics requirement should not use ORIE 3500 Engineering Probability and Statistics II to fulfill the requirement for an advanced course.
6. Biology majors in the College of Agriculture and Life Sciences who select this Program of Study are allowed to take up to 61 credit hours in the endowed colleges due to the high number of required endowed courses for this Program of Study.
4. ***Ecology and Evolutionary Biology***: BIOEE 2610 Ecology and the Environment. *Effective fall semester 2005*, new students must also complete 10 credits from the following lists: (a) Principles, (b) Organisms, and (c) Ecological and Evolutionary Processes. One course must be chosen from list (a) and a second either from list (b) *or* (c). The remaining credits can be satisfied with courses from all three lists. Students are encouraged to take at least one course from each list.

   a. Principles: BIOEE 4530 Speciation; BIOEE 4580 Community Ecology; BIOEE 4600 Theoretical Ecology; BIOEE 4640 Macroevolution; BIOEE 4800/ENTOM 4700 Ecological Genetics; BIOEE 4780 Ecosystem Biology; NTRES 3100 Applied Population Ecology.

   b. Organisms: BIOEE 2740 The Vertebrates: Structure, Function, and Evolution; BIOEE 3730 Biodiversity and Biology of the Marine Invertebrates or BIOSM 3760 Marine Invertebrate Zoology; BIOEE 4500 and 4501 Mammalogy, lec and lab; BIOEE 4700 and 4701 Herpetology lec and lab; BIOEE 4750 Ornithology; BIOEE 4760 Biology of Fishes; ENTOM 2120 Insect Biology; BIOPL 2410 Introductory Botany; BIOPL 4480 Plant Evolution and the Fossil Record; PLPA 3090 Fungi; BIOSM 4490 Marine Botany.

   c. Ecological and Evolutionary Processes: BIOEE 2630 Field Ecology; BIOEE 2650 Tropical Field Ecology and Behavior; NS/ANTHR 2750 Human Biology and Evolution; BIOEE/BIONB/ENTOM 3690 Chemical Ecology; BIOEE/EAS 3500 Dynamics of Marine Ecosystems; BIOEE/MATH 3620 Dynamic Models in Biology; BIOEE 4460 Plant Behavior—Induced Plant Responses to Biotic Stresses; BIOEE/ENTOM 4550 Insect Ecology; BIOEE/NTRES 4560 Stream Ecology; BIOEE 4570 and 4571 Limnology: Ecology of Lakes, lec and lab; BIOEE/EAS 4620 Marine Ecology; BIOEE 4660 and 4661 Physiological Plant Ecology, lec and lab; BIOEE/HORT 4730 Ecology of Agricultural Systems; NTRES 4200 Forest Ecology; BIOSM 4130 Research in Marine Biology; NTRES 4220 and 4221 Wetland Ecology and Management, lec and lab; BIOMI 4180 Microbial Ecology; CSS/HORT 4660 Soil Ecology; BIOPL/ENTOM 4400 Phylogenetic Systematics; BIOPL 4470 Molecular Systematics; BIOPL/ENTOM 4530 Principles and Practice of Historical Biogeography; BIOEE/EAS 4790 Paleobiology; BIOGD 4840 Molecular Evolution.

   Note: Students also are encouraged to gain experience in some aspect of field biology through course work at a biological field station and can apply up to 6 credits in the place of courses from lists (b) or (c). For example, students may apply 6 credits from the following courses taken at the Shoals Marine Laboratory (BIOSM): BIOSM 3080 Field Microbial Ecology; BIOSM 3090 Coastal Ecology and Bioclimates; BIOSM 3210 Anatomy and Function of Marine Vertebrates; BIOSM 3740 Field Ornithology; BIOSM 3770 Diversity of Fishes; BIOSM 4770 Marine Vertebrates; and BIOSM courses in lists b and c. The Ecology and Evolutionary Biology program of study offers a specialization in Marine Biology and Oceanography (for a description, see "Courses in Marine Science"). The Organization for Tropical Studies (OTS) offers an Undergraduate Semester Abroad Program, featuring two courses (Fundamentals in Tropical Biology and Field Research in Tropical Biology) that can count as two 3-credit courses toward the concentration. Six credits can be applied from the 15-week fall "Semester in Environmental Science" program offered by the Woods Hole Marine Biological Laboratory.

5. ***General Biology:*** The program of study in general biology requires a minimum of 13 credit hours in addition to courses counted toward requirements 1–9 on pages 155–6. These 13 credits must include:

   a. One course from each of three different programs of study in biology. Only those courses specifically listed as fulfilling a program of study requirement are acceptable without permission of advisor.

   b. A course with a laboratory.

   c. A minimum of two upper-level (3000 and above) courses of 2 or more credits each.

   100-level courses are not acceptable for meeting any of these requirements. BIOG 4980 may not be used to fulfill the requirements of this program of

study. BIOG 4990 (minimum of 2 credits, but no more than 3 credits) may count as one of the upper-level courses, and may count as the laboratory course with approval of the advisor, but it cannot count as a course representing a program of study.

Note: It is possible to use a single course to fulfill more than one requirement. For example, BIOAP 4130 Histology could count in all three areas: as a course in the Animal Physiology program of study, as an upper-level course, and as a course with a lab.

6. ***Genetics and Development:*** A minimum of 13 credits, usually chosen from the following courses: BIOGD 3850 Developmental Biology; any BIOGD course of 4000 level or higher; BIOMI 4200 Microbial Genomics; BIOAP 4750 Mechanisms Underlying Mammalian Developmental Defects; BIONB 4930 Developmental Neurobiology; BIONB 4950 Molecular and Genetic Approaches to Neuroscience; BIOBM 6330 Biosynthesis of Macromolecules; BIOBM 6390 The Nucleus; BIOEE 4530 Speciation; PLBR 4030 Genetic Improvement of Crop Plants; PLBR 6060 Advanced Plant Genetics; BIOPL 3430 Molecular Biology and Genetic Engineering of Plants; BIOPL 4821 Molecular Plant-Pathogen Interactions I; BIOPL 4822 Molecular Plant-Pathogen Interactions II; BIOPL 4823 Molecular Plant-Microbe Interactions; BIOPL 4824 Plant Gene Evolution and Phylogeny; BIOPL 4825 Molecular Biology of Plant Organelles; BIOPL 4826 Plant Biotechnology; BIOPL 4827 Plant Cell Walls: Structure to Proteome; BIOPL 4828 Plant Imaging; BIOPL 4829 Light Signal Transduction in Plants; BIOPL 4831 Concepts and Techniques in Plant Molecular Biology; BIOPL 4832 Proteomics in Plant Biology; BIOPL 4833 Plant Genome Organization and Function; BIOPL 4834 Molecular Aspects of Plant Development; BIOPL 4835 Molecular Breeding; BIOPL 4836 Plant Senescence; BIOPL 6410 Laboratory in Plant Molecular Biology. Up to 3 credits for this program of study may be chosen from other biological sciences courses, including BIOGD 3990 Research Practicum in Molecular and Cellular Biology, or BIOG 4990 Independent Undergraduate Research in Biology, with approval from the faculty advisor.

7. ***Insect Biology:*** ENTOM 2120 Insect Biology plus a minimum of three additional courses totaling at least 9 credits selected from the following two groups. At least one of the three additional courses must be selected from group a.

   Group a: ENTOM 3310 Insect Phylogeny and Evolution; ENTOM 3330 Larval Insect Biology; ENTOM 3520 Medical and Veterinary Entomology; ENTOM 4440 Integrated Pest Management; ENTOM 4550 Insect Ecology; ENTOM 4630 Invertebrate Pathology; ENTOM 4830 Insect Physiology

   Group b: ENTOM 3150 Spider Biology; ENTOM 3250 Insect Behavior; ENTOM 3440 Insect Conservation Biology; ENTOM 3690 Chemical Ecology; ENTOM 3700 Pesticides, Environment, and Human Health; ENTOM 4530 Principles and Practice of Historical Biogeography; NTRES 4560 Stream Ecology; ENTOM 4700 Ecological Genetics; ENTOM 4770 Biological Control; ENTOM 4900 Insect Toxicology

8. ***Microbiology:*** Students in the Microbiology program of study must complete BIOMI 2900 General Microbiology, Lec; BIOMI 2910 General Microbiology, Lab. At least 8 additional credits are required, which must include at least one of the following courses: BIOMI 4140 Bacterial Diversity; BIOMI 4160 Bacterial Physiology; BIOMI 4180 Microbial Ecology; BIOMI 4850 Bacterial Genetics.

   Additional approved courses are included in the list below. Students are invited to complete their requirements in one of three areas of interest (these are only recommended areas of interest; students can design their own course list as long as they meet the requirements described above): (a) Prokaryotic Biology, (b) Molecular Microbiology and Biotechnology, and (c) Pathogenic Microbiology. Courses acceptable to the program of study that cover topics related to a particular area of interest are:

   Prokaryotic Biology: BIOMI 3910 Advanced Microbiology Laboratory; BIOMI 4140 Bacterial Diversity; BIOMI 4160 Bacterial Physiology; and BIOMI 4180 Microbial Ecology.

   Molecular Microbiology and Biotechnology: BIOMI 3910 Advanced Microbiology Laboratory; BIOMI 4160 Bacterial Physiology; BIOMI 4200 Microbial Genomics; BIOMI 4850 Bacterial Genetics; and BIOMI 3940 Applied and Food Microbiology.

   Pathogenic Microbiology: BIOMI 4040 Pathogenic Bacteriology and Mycology; BIOMI 4090 Principles of Virology; BIOMI 4310 Medical Parasitology; and BIOMI 4850 Bacterial Genetics.

9. ***Molecular and Cell Biology:*** CHEM 3570–3580 or 3590–3600; BIOBM 4320 Survey of Cell Biology; BIOBM 4400 Laboratory in Biochemistry and Molecular Biology, or BIONB 4300 Experimental Molecular Neurobiology; and at least 7 additional credits of courses that have a cell biological or molecular biological orientation. The 7 additional hours should include at least two courses from the following list: BIOAP 4160 Cellular Physiology and Genomics Laboratory; BIOGD 4010 Genomic Analysis; BIOBM 4340 Applications of Molecular Biology; BIOBM 4350–4360 Undergraduate Seminar in Biochemistry; BIOBM 4370 Regulation of Cell Proliferation, Senescence, and Death; BIOBM 4390 Molecular Basis of Human Disease; BIOG 3050 Basic Immunology Lectures; BIOGD 3850 Developmental Biology; BIOGD 4000 A Genomics Approach to Studying Life; BIOGD 4610 Development and Evolution; BIOGD 4840 Molecular Evolution; BIOGD 4860 Advanced Eukaryotic Genetics; BIOGD 4870 Human Genomics; BIOGD 4900 Manipulating The Mouse Genome; BIOMI 4090 Principles of Virology; BIOMI 4200 Microbial Genomics; BIOMI 4850 Bacterial Genetics; BIONB 4250 Molecular Neurophysiology; BIONB 4950 Molecular and Genetic Approaches to Neurosciences; BIOPL 3430 Molecular Biology and Genetic Engineering of Plants; BIOPL 3431 Laboratory in Molecular Biology and Genetic Engineering of Plants; BIOPL 4440 Plant Cell Biology. Graduate-level courses such as BIOBM 6310 Protein Structure and Function; BIOBM 6330 Biosynthesis of Macromolecules; BIOBM 6360 Functional Organization of Eukaryotic Cells; and BIOBM 6390 The Nucleus are also acceptable by permission of advisor. Five hours of biochemistry are recommended (BIOBM 3310 and 3320, or 3300 and 3340, or 3330 and 3340). CHEM 2070–2080 or 2150–2160 should be completed in the freshman year.

10. ***Neurobiology and Behavior:*** The two-semester introductory course sequence Neurobiology and Behavior I and II (BIONB 2210 and 2220) with discussion section (4 credits per semester) and 7 additional credits. The 7 additional credits must include at least one advanced course from the BIONB offerings. "Topics" courses (BIONB 4200s and 7200s), independent study (BIOG 4990), BIONB 3210, and PSYCH 4230 may be used as supplemental credits but **do not** qualify as advanced courses.

Note: Students who declare the program of study in Neurobiology and Behavior after taking BIONB 2210 or 2220 for only 3 credits must still take the 1-credit discussion section in BIONB 2210 and 2220. To arrange this, the student should consult the professors in charge of the two courses.

11. ***Nutrition:*** NS 3310 Physiological and Biochemical Bases of Human Nutrition (4 credits) and at least 9 credits of additional course work in the biological aspects of nutrition, such as NS 1220 Nutrition and the Life Cycle; NS 3150 Obesity and the Regulation of Body Weight; NS 3320 Methods in Nutritional Sciences; NS 3410 Human Anatomy and Physiology; NS 3470 Human Growth and Development; NS 4210 Nutrition and Exercise; NS 4410 Nutrition and Disease; NS 6030 (alternate years) Mineral Nutrition: Metabolic, Health, and Environmental Aspects; NS 6140 Topics in Maternal and Child Nutrition; NS 6310 Micronutrients: Function, Homeostasis, and Metabolism; and NS 6320 Regulation of Macronutrient Metabolism. Some courses require NS 1150 Nutrition, Health, and Society, which may be used as part of the additional 9 credits.

Note: For students in the College of Agriculture and Life Sciences, credits in NS courses count toward the required 55 CALS credits. For students in the College of Arts and Sciences, NS credits will count toward the 100 hours required in A&S if those credits fulfill major requirements.

12. ***Plant Biology:*** Students choose one area of study from the following two options:

    Option (a) Botany: Students are required to take BIOPL 2410 Introductory Botany. Students should then choose, with the aid of their faculty advisor, a minimum of three of the following courses, for a total of at least 10 additional credits, to round out their botanical training: BIOPL 2420

and 2421 Plant Function and Growth, Lec and Lab; BIOPL 2430 Taxonomy of Cultivated Plants; BIOPL 2450 Plant Biology; BIOPL 2470 Ethnobiology; BIOPL 2480 Taxonomy of Vascular Plants; BIOPL 3420 and 3421 Plant Physiology, Lec and Lab; BIOPL 3430 and 3431 Molecular Biology and Genetic Engineering of Plants, Lec and Lab; BIOPL 3450 Plant Anatomy; BIOPL 3480 The Healing Forest; BIOPL 3590 Biology of Grasses; BIOPL 3800 Strategies and Methods in Drug Discovery; BIOPL 4040 Crop Evolution, Domestication, and Diversity; BIOPL 4220 Plant Development; BIOPL 4400 Phylogenetic Systematics; BIOPL 4420 Current Topics in Ethnobiology; BIOPL 4440 Plant Cell Biology; BIOPL 4470 Molecular Systematics; BIOPL 4480 Plant Evolution and the Fossil Record; BIOPL 4490 Green Signals and Triggers—The Plant Hormones; BIOPL 4520/4521 Systematics of Tropical Plants and Field Lab; BIOPL 4530 Principles and Practice of Historical Biogeography; BIOPL 4620 Plant Biochemistry; or BIOEE 4660 and 4661 Physiological Plant Ecology, Lec and Lab.

Option (b) Plant Biotechnology: Students are required to take BIOPL 3430 and 3431 Molecular Biology and Genetic Engineering of Plants, Lec and Lab. Students choose, in consultation with their faculty advisor, a minimum of 10 additional credits from the following list: BIOPL 2410 Introductory Botany; BIOPL 2420 and 2421 Plant Function and Growth, Lec and Lab; BIOPL 3420 and 3421 Plant Physiology, Lec and Lab; BIOPL 4220 Plant Development; BIOPL 4440 Plant Cell Biology; BIOPL 4620 Plant Biochemistry; BIOPL 4821 Molecular Plant-Pathogen Interactions I; BIOPL 4822 Molecular Plant-Pathogen Interactions II; BIOPL 4823 Molecular Plant-Microbe Interactions; BIOPL 4824 Plant Gene Evolution and Phylogeny; BIOPL 4825 Molecular Biology of Plant Organelles; BIOPL 4826 Plant Biotechnology; BIOPL 4827 Plant Cell Walls: Structure to Proteome; BIOPL 4828 Plant Imaging; BIOPL 4829 Light Signal Transduction in Plants; BIOPL 4831 Concepts and Techniques in Plant Molecular Biology; BIOPL 4832 Proteomics in Plant Biology; BIOPL 4833 Plant Genome Organization and Function; BIOPL 4834 Molecular Aspects of Plant Development; BIOPL 4835 Molecular Breeding; BIOPL 4836 Plant Senescence; PLBR 4010 Plant Cell and Tissue Culture; or PLBR 4020 Plant Tissue Culture Laboratory.

13. ***Systematics and Biotic Diversity:*** A minimum of 13 credits from the following two groups, including at least 7 credits from group a and three from group b and at least two laboratory courses (marked with *). BIOG 4990, Independent Undergraduate Research in Biology, with approval of the advisor, can be used in fulfillment of up to 4 credits in group (a), and can count as one laboratory course if it has a laboratory component of 2 or more credits.

    a. *BIOEE 2640 Tropical Field Ornithology; *BIOEE 2740 The Vertebrates: Structure, Function, and Evolution; BIOEE 3710 Human Paleontology; *BIOEE 3730 Biology of the Marine Invertebrates; BIOEE 4050 Biology of the Neotropics; BIOEE 4700 Herpetology, Lec; *BIOEE 4500 Mammalogy; *BIOEE 4701 Herpetology, Lab; *BIOEE 4750 Ornithology; *BIOEE 4760 Biology of Fishes; BIOEE 4770 Marine Invertebrates Seminar; BIOMI 2900 General Microbiology, Lec; *BIOMI 2910 General Microbiology, Lab; BIOMI 4140 Prokaryotic Diversity, Lec; *BIOPL 2410 Introductory Botany; *BIOPL 2430 Taxonomy of Cultivated Plants; *BIOPL 2450 Plant Biology; BIOPL 2470 Ethnobiology; *BIOPL 2480 Taxonomy of Vascular Plants; BIOPL 3480 The Healing Forest; BIOPL 3590 Biology of Grasses; BIOPL 4520 Systematics of Tropical Plants; *BIOPL 4521 Systematics of Tropical Plants: Field Laboratory; *ENTOM 2120 Insect Biology; ENTOM 2150 Spider Biology: Life on a Silken Thread; ENTOM 3150 Spider Biology; *ENTOM 3310 Introductory Insect Systematics; *ENTOM 3330 Maggots, Grubs, and Cutworms: Larval Insect Biology; PLPA 3090 Fungi; *PLPA 3190 Mushrooms of Field and Forest.

    b. BIOEE 4530 Speciation; BIOEE 4640 Macroevolution; BIOEE 4790 Paleobiology; *BIOPL 4400 Phylogenetic Systematics; BIOPL 4420 Current Topics in Ethnobiology BIOPL 4470 Molecular Systematics; *BIOPL 4480 Plant Evolution and the Fossil Record; *BIOPL 4530 Principles and Practices of Historical Biogeography.

The Minor in Biological Sciences

The minor in biological sciences has been designed to provide students with a broad background in biology while allowing them some flexibility to choose courses of interest. Students must have completed one full year of introductory biology (or its equivalent) to declare the minor. Students will complete 12 to 15 credits by taking either all three biology core course requirements or two biology core course requirements and 5 or more biology credits from the lists of approved program of study courses found on pages 159–162 of this catalog.

Biology core courses

1. Biochemistry: BIOBM 3300, 3330, or 3310–3320; one year of general chemistry and organic chemistry lecture (CHEM 1570 or 3570–3580) are prerequisites
2. Evolutionary biology: BIOEE 2780 or BIOPL 4480
3. Genetics: BIOGD 2810

Notes:

- BIOG 4990 Independent Research may not be used to fulfill any requirement for the minor. No course substitutions are allowed. With the exception of transfer and study abroad students, no biology courses taken at other institutions will count toward the minor.
- External transfer students must complete the core biology courses at Cornell. Students who are fulfilling the minor requirements under Option 2 must complete a minimum of one program of study course of at least 3 credits at Cornell.
- All courses for the minor must be taken for a letter grade unless a course is offered S-U only.
- Applications for the minor are located in 216 Stimson Hall. See Bonnie Comella, Jeff McCaffrey, or Wendy Aquadro for academic advising and for certifying completion of the minor.

Independent Research and Honors Program

Biology majors are encouraged to consider participating in individual research under the direction of a Cornell faculty member. Students interested in beginning research should contact faculty members who have compatible research interests. Information about faculty research interests and undergraduate research opportunities is available in the Office of Undergraduate Biology, 216 Stimson Hall, and at www.biology.cornell.edu.

Faculty members may consider the student's previous academic accomplishments, interests and career goals, and the availability of space and equipment when agreeing to supervise a student in their laboratory. Students conducting research for the first time must enroll in BIOG 2990, an S-U course designed to introduce students to research. After the first semester, students enroll in BIOG 4990. Registration for both of these classes is done in the Office of Undergraduate Biology in 216 Stimson Hall. Students may work with faculty in any department on campus as long as the research topic is biological. Students may not earn credit for research done off campus, unless supervised by a Cornell faculty member. Up to 3 credits of research may be used to complete the programs of study in general biology, genetics and development, systematic and biotic diversity, as well as 4 credits in neurobiology and behavior.

The honors program in biological sciences is designed to offer advanced training in life science research through the performance of an original research project under the direct guidance of a member of the Cornell faculty. Biology majors planning on graduating with honors must apply to the Biology Honors Program in the spring of their junior year. Applications and information are available in the Office of Undergraduate Biology, 216 Stimson Hall, or at www.biology.cornell.edu/research/honors.html. To qualify for the program, students must have been accepted into the biological sciences major, have completed at least 30 credits at Cornell, and have a cumulative Cornell grade point average (GPA) of at least 3.0. In addition, students must have at least a 3.0 cumulative Cornell GPA in all biology, chemistry, mathematics, and physics courses. (Grades earned in courses in other departments that are used to fulfill biology major requirements are included in this computation.) In addition, candidates must find a Cornell faculty member to supervise their research. An honors candidate usually enrolls for credit in BIOG 4990 Undergraduate Research in Biology under the direction of the faculty member acting as honors supervisor, although the honors program does not require enrollment for credit. Students accepted into the honors program are required to participate in honors research seminars during their senior year; submit an acceptable honors thesis; complete all major requirements; and maintain a 3.0 Cornell cumulative and science GPA

through graduation. Recommendation to the faculty that a candidate graduate with honors and at what level of honors is the responsibility of the Honors Program Committee. The student's final GPA and quality of his or her thesis are factors in determining the level of honors recommended.

Students interested in the honors program are strongly encouraged to begin their research projects in their junior year and to consider spending the following summer at Cornell engaged in full-time research on their honors project.

Biology majors who are considering study abroad and graduating with honors are encouraged to meet with their academic and research advisor during their sophomore year to carefully plan their academic schedule to meet the requirements of the honors program.

Application forms, requirements, deadline dates for the honors program and the Hughes Scholars Program, and information pertaining to faculty research may be obtained at the Office of Undergraduate Biology, 216 Stimson Hall, and at www.biology.cornell.edu.

CURRICULUM COMMITTEE

Many decisions pertaining to the curriculum and to the programs of study are made by the Biology Curriculum Committee, which meets monthly during the academic year. The committee consists of faculty and elected student members and welcomes advice and suggestions from all interested parties.

ADVISING

Students in need of academic advice are encouraged to consult their advisors or see an academic advisor in the Office of Undergraduate Biology, 216 Stimson Hall.

Students interested in marine biology should visit the Shoals Marine Laboratory Office, G14 Stimson Hall.

Students interested in the Biology and Society major should see pages 487–494 in the College of Arts and Sciences section of this catalog.

TRANSFERRING CREDIT

Biology majors are required to complete all three biology core courses (biochemistry, evolution, and genetics) at Cornell.

External transfer students are limited to transferring one core biology course and one course of up to 3 credits toward their program of study. See the Office of Undergraduate Biology for approval procedures.

Students who matriculated to Cornell as freshmen and Study Abroad students may transfer program of study courses at the discretion of their advisor. Study Abroad students must obtain approval from the Office of Undergraduate Biology, Director of Advising, to transfer biology core courses.

Online course credit is not acceptable to transfer for any biology course.

GENERAL COURSES (BIOG)

Three introductory biology course sequences are taught during the academic year: BIOG 1101–1104, 1105–1106, and 1109–1110; and one during the eight-week summer session: BIOG 1107–1108. BIOG 1101–1104, 1105–1106, and 1107–1108 are intended for biological sciences majors and other students needing 8 credits from an introductory sequence for majors (e.g., students in a premedical curriculum). Any of these sequences meet the prerequisite for upper-level courses listing "one year of introductory biology for majors" as a prerequisite. BIOG 1109–1110 is a course sequence intended for nonmajors and meets the prerequisite for many, but not all, upper-level courses listing "one year of introductory biology" as a prerequisite. Students can earn a maximum of 8 credits in introductory biology (including advanced placement credits).

BIOG 1101–1102 Biological Sciences, Lectures

1101, fall; 1102, spring. 2 credits each semester. Corequisite: BIOG 1103 (fall) or 1104 (spring). Prerequisite: for 1102, D or better in 1101 or permission of instructor. May not be taken for credit after BIOG 1105–1106 or 1109–1110. S-U or letter grades by permission of instructor. First lec of fall semester, F Aug. 29. No admittance after second week of classes. Evening prelims: fall, Sept. 25 and Nov. 4; spring, Feb. 19 and March 31. Fall, staff; spring, staff.

Designed for students who intend to specialize in biological sciences. The fall semester covers the chemical and cellular basis of life, energy transformations, physiology, neurobiology, and behavior. The spring semester covers genetics, development, evolution, and ecology. Each topic is considered in terms of modern evolutionary theory, and discussions of plant and animal systems are integrated.

BIOG 1103–1104 Biological Sciences, Laboratory

1103, fall; 1104, spring. 2 credits each semester. Corequisite: BIOG 1101 (fall) or 1102 (spring). Prerequisite: for 1104, D or better in 1103 or permission of instructor. Students registered for lab courses who are more than 10 minutes late for first meeting of lab forfeit registration in that course; no admittance after second week of classes. First lab of fall: week of Sept. 1; first lab of spring: week of Jan. 19. S-U or letter grades by permission of instructor. K.-C. Chen.

Designed to provide lab experience with major biological phenomena to support an understanding of the important concepts, principles, and theories of modern biology. A second objective is to help students gain expertise in the methods used by biologists to construct new knowledge. Students are exposed to basic concepts, research methods, including laboratory and data transformation techniques, and instrumentation in the major areas of biology. First-semester topics include biochemistry, physiology, plant biology, and scientific method and poster development. In the second semester, laboratory experience is provided in genetics, biotechnology, invertebrate diversity, plant and animal development, and ecology. During the first semester, students dissect a doubly pithed frog (pithing is done by the staff). Students dissect several invertebrates during the second semester. For those students who object to animal dissection, alternative materials are available for study. However, testing involves identification of important structures in real organisms.

BIOG 1105–1106 Introductory Biology

1105, fall; 1106, spring. 4 credits each semester; 2 credits by permission of instructor. Limited to 200 students. Taking 1105–1106 in sequence preferred but not required. May not be taken for credit after BIOG 1101–1104 or 1109–1110. No admittance after first week of classes. First lec of fall semester R Aug. 28, 9:05; additional study and lab. D. Campbell.

Designed primarily for biology majors, preprofessionals, and other students who desire a challenging, broad introduction to fundamental concepts of biology. Cell biology, physiology, anatomy, and biochemistry are strongly emphasized in BIOG 1105. BIOG 1106 covers genetics, development, ecology, evolution, behavior, and the diversity of organisms. Students who plan to concentrate in anatomy and physiology should consider taking this course because of the strong emphasis on organismal biology. Because some testing involves the use of predissected specimens, students who object to dissections should take BIOG 1101–1104. The course uses an autotutorial format and offers considerable flexibility in scheduling. Completion of the course requires mastery of a group of core units. Testing on these units is primarily by oral examination. Students who elect to take the course must be able to meet deadlines. Four formal laboratory sessions are offered each semester; additional laboratory work is included in the core units. Evaluation is based on written reports on experimental work, practical exams, and a comprehensive final exam. Web site: instruct1.cit.cornell.edu/courses/biog105.

BIOG 1107–1108 General Biology

Summer, 8-week session; 1107, weeks 1–4; 1108, weeks 5–8. 4 credits each. 1107–1108 fulfills introductory biology requirement for majors and forms suitable introductory biology course sequence for students intending to go to medical school. Prerequisite: one year of college or permission of instructor; for BIOG 1108, a grade of D or better in the prerequisite courses (BIOG 1101, 1103, 1105, or 1107). Fee for weeks 1–4: $25; for weeks 5–8, $25. Staff.

Designed for students who plan further study in biology. 1107 covers biological metabolism, first at the molecular level and then progressively to the organ system level. The laboratory work involves an introduction to some major techniques, vertebrate dissection, and a survey of plant organization. 1108 seeks to integrate the topics of genetics, developmental biology, population biology, and ecology in a general consideration of biological evolution. The laboratory work is a continuation of the material covered in 1107 and involves more techniques, a survey of animal organization, and the design and performance of a field study. For those students who object to animal dissection, alternative materials are available for study. However, testing involves identification of important structures in real organisms.

BIOG 1109–1110 Biological Principles
1109, fall; 1110, spring. 3 credits each semester includes lecture and lab. Limited to 500 students. Nonmajors survey course, not appropriate for major in biological science or premed requirement. Both BIOG 1109 and 1110, taken in either order, are required to fulfill distribution requirement in CALS and Human Ecology. Either course fulfills Arts and Sciences distribution requirement. Students with transfer credit must consult with course instructors for appropriate course placement. Due to overlap in content, BIOG 1109 may not be taken after BIOG 1102 or 1106, or equivalent, and BIOG 1110 may not be taken after BIOG 1101, 1105, or equivalent. Note: This course may not satisfy prerequisite for upper-level courses in biology. Letter grades only. Prelims: fall (2 in class); spring (2 in class). H. Greene, R. Wayne, E. Balko, and staff.
Both semesters of Biological Principles are intended to appeal to anyone who seeks an overview of general biology topics and current biological issues. BIOG 1109 is offered during fall semester and introduces students to the diversity of biological organisms, Mendelian genetics, behavior, and ecology and culminates by tying together the information covered during the semester with current issues involving global climate change and biomimetic research. BIOG 1110 integrates instruction about cells, organ systems, metabolic processes, reproduction, sexually transmitted infections, contraception and bioengineering with the students' understanding of human biology. The culminating activities for spring semester includes hands-on activities involving some of the techniques used by health care professionals and forensic scientists, plus student-led debates about bioengineering. Laboratory sessions meeting alternate weeks (total of 6 labs per semester) are used for problem-solving experiments, demonstrations, discussions, and dissections (preserved vertebrate, invertebrate, and plant materials). For those students who object to dissection, alternative materials are available for study without grade penalty. Testing on dissection labs involves identification of important structures in real organisms. Registration for the lab section is required at the time of course registration. All students must enroll in lecture and lab using electronic course enrollment.

BIOG 1115 Biology Summer Bridge
Summer. 4 credits. Letter grades only. R. Booker.
This is an inquiry-based course intended for prefreshmen who intend to major in life sciences or pursue a career in the health professions. Topics include the molecular and cellular basis of life, genetics, physiology, and natural selection. The course includes an intensive six-hour-per-week laboratory, a writing workshop, and a study skills session. All students will be required to be part of the Biology Summer Bridge Living-Learning community.

BIOG 1250 Biology Seminar
Fall and spring. 1 credit. Prerequisite: first-year standing or permission of instructor. S-U grades only. Staff.
A first-year seminar designed for students with Biology AP credit or a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

BIOG 2000 Special Studies in Biology
Fall, spring, or summer. 1–3 credits. Prerequisite: written permission from Office of Undergraduate Biology. Students must register in 216 Stimson Hall. S-U or letter grades by permission of instructor. Staff.
Registration device for students who want to take only a portion of a regular biological sciences course—for example, only the lectures or only the laboratory in a course that includes both. Only students who have already had training equivalent to the portion of the regular course that is to be omitted may register in this manner. This course may not be substituted for 100-level courses and may not be used to fulfil college distribution requirements except by permission from the Office of Undergraduate Biology.

BIOG 2990 Introduction to Research Methods in Biology
Fall, spring, or summer. Variable credit; max. 3 suggested. S-U grades only. Recommended for freshmen and sophomores. Students must register for credit in Office of Undergraduate Biology, 216 Stimson Hall. Applications available in OUB and at www.bio.cornell.edu. **Add deadline is three days before university deadline.** Any Cornell faculty member whose research field is biological in nature may serve as a supervisor for this course. Non-Cornell supervisors not acceptable.
Intended for students who are new to undergraduate research. Students enrolled in BIOG 2990 may be reading scientific literature, learning research techniques, or assisting with ongoing research. The faculty supervisor determines the work goals and the form of the final report.

BIOG 3050 Basic Immunology Lectures (also VETMI 3150)
Fall. 3 credits. Highly recommended: basic courses in microbiology, biochemistry, and genetics. S-U or letter grades. Lec. J. A. Appleton.
For description, see VETMI 3150.

BIOG 4000 Undergraduate Seminar in Biology
Fall or spring. Variable credit; 1–3 assigned for individual seminar offerings; participation in Weill Cornell Medical College in Qatar required. S-U or letter grades. Staff.
Specialized seminars on topics of interest to undergraduates studying at Weill Cornell Medical College in Qatar.

BIOG 4040 Planning for Graduate Study in Biology
Fall. 1 credit. S-U grades only. L. Southard.
For students who plan to pursue a graduate degree leading to a research career. Selected topics include information on academic and industrial research careers, selecting appropriate graduate programs, and options for funding. Features faculty, graduate student, and outside speakers. Students write and receive feedback on personal statements.

BIOG 4080 Presentation Skills for Biologists
Spring. 1 credit. S-U grades only. Prerequisite: research experience. Priority given to students accepted into Biology Honors Program. L. Southard and G. Hess.
Covers oral and written communication skills used in presenting research to other scientists. Topics include organization and writing of scientific papers, presentation tips for research seminars, and preparation of visual aids using Microsoft Power Point. All students present a 10-minute seminar on their research and evaluate other presentations.

BIOG 4100 Teaching High School Biology
Fall. 3 credits. Prerequisite: one year introductory biology; permission of instructor. S-U or letter grades. Offered alternate years. L. Southard.
Gives students the opportunity to experience teaching high school science. Students select an important biological concept, then develop inquiry-based teaching plans appropriate for high school students. The first part of the course consists of lectures, discussion, and laboratory experiments, which familiarize the students with the scientific content. Students then work in teams with high school teachers to develop their curriculum. The final part of the course includes practice presentations and teaching at regional high schools.

BIOG 4940 Special Topics in Biological Sciences
Fall or spring. 1–4 credits, variable. S-U or letter grades.
Biological Sciences offers "trial" courses or seminars under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under this number will be approved by the Biological Sciences Curriculum Committee, and the same course is not to be offered more than twice under this number.

BIOG 4980 Teaching Experience
Fall or spring. 1–4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, upon petition (one time only) to their class dean, carry fewer than 12 *other* credits and remain in good standing. This would affect Dean's List eligibility but not eligibility for graduating with distinction. S-U or letter grades by permission of instructor. Staff.
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and assisting in biology courses. This experience may include supervised participation in a discussion group, assisting in a biology laboratory, assisting in field biology, or tutoring.

BIOG 4990 Independent Undergraduate Research in Biology
Fall, spring, or summer. Variable credit. S-U or letter grades. Note: Arts students may not register for more than 6 credits per semester with one supervisor or 8 credits per semester with more than one supervisor. Students in CALS may use up to 15 credits of independent study (BIOG 4990, 4980) toward graduation. Up to 3 credits of research may be used to complete programs of study in General Biology, Genetics and Development, and Systematics and Biotic Diversity, and 4 credits of research in Neurobiology and Behavior. Prerequisite: one semester of BIOG 2990 or equivalent or permission of instructor and Office of Undergraduate Biology.

For students with previous undergraduate experience conducting biological research at Cornell. Students enrolled for this credit should be doing independent work on their own project. Registration forms are available in OUB and on the web at www.bio.cornell.edu. **Add deadline is three days before university deadline.** Each student must submit proposed research project description during course registration. Any Cornell faculty member whose research field is biological in nature may serve as supervisor for this course. Non-Cornell supervisors not acceptable.

BIOG 6000 Graduate Seminar in Biology
Fall or spring. Variable credit (1–3 credits assigned for individual seminar offerings). May be repeated for credit. S-U or letter grades. Staff.
Specialized seminars on topics of interest to graduate students presented by biology faculty including visiting faculty.

ANIMAL PHYSIOLOGY (BIOAP)

BIOAP 1250 Biology Seminar
Fall and spring. 1 credit. Prerequisite: first-year standing or permission of instructor. S-U grades only. Staff.
A first-year seminar designed for students with Biology AP credit or a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

[BIOAP 2140 The Biological Basis of Sex Differences (also BSOC 2141, FGSS 2140)
Fall. 3 credits. Prerequisite: one year introductory biology. S-U or letter grades. Offered alternate years; next offered 2010–2011. J. E. Fortune.
Examines the structural and functional differences between the sexes. Emphasizes mechanisms of mammalian reproduction; where possible, special attention is given to studies of humans (behavior, mental, and physical capabilities). Current evidence on the effects of gender on nonreproductive aspects of life is discussed. This course is intended to provide students with a basic knowledge of reproductive endocrinology and with a basis for objective evaluation of sex differences in relation to contemporary life.]

BIOAP 3110 Introductory Animal Physiology (also VTBMS 3460)
Fall. 3 credits. Prerequisites: one year college biology, chemistry, and mathematics. Recommended: previous or concurrent physics course. S-U or letter grades by permission of instructor. Evening prelims. M. Baustian.
General course in animal physiology emphasizing principles of operation, regulation, and integration common to a broad range of living systems from the cellular to the organismal level. Structure/function relationships are stressed along with underlying physico-chemical mechanisms.

BIOAP 3120 Farm Animal Behavior (also ANSC 3050)
Spring. 2 credits. Prerequisites: one year introductory biology, and introductory animal physiology (ANSC 1100 or equivalent is sufficient or BIOAP 3110). Recommended: at least one animal production course or equivalent experience. S-U or letter grades. P. Perry and K. A. Houpt.
For description, see ANSC 3050.

BIOAP 3160 Cellular Physiology
Spring. 3 credits. Pre- or corequisite: BIOBM 3300 or 3310 and 3320 or 3330. Evening prelims. A. Quaroni.
A comprehensive course covering the general characteristics of eukaryotic cells; the structure, composition, and function of subcellular organelles; and the major signal transduction pathways regulating a variety of physiological cell activities. Among the main subjects covered are absorption and transport processes, mechanism of action of signaling molecules (hormones), the cell cycle and regulation of cell proliferation, cell-cell communication, extracellular matrix, and carcinogenesis.

BIOAP 3190 Animal Physiology Experimentation
Fall. 4 credits. Limited to 40 students per lab sec. Prerequisite: BIOAP 3110 or permission of instructor. For pre-med, pre-vet juniors and seniors and graduate students interested in biomedical science. Letter grades only. E. R. Loew, N. A. Lorr, and staff.
Student-conducted in vitro and in vivo experiments designed to illustrate basic physiological processes, physiological research techniques, instrumentation, experimental design, and interpretation of results. Techniques include anesthesia, surgical procedures, dissection, and real-time computer recording and analysis. Experiments with isolated living tissues or live anesthetized animals examine properties of membranes and epithelia, blood, nerves, skeletal and smooth muscle; cardiovascular, respiratory, renal, and reproductive function and their regulation by the nervous and endocrine systems.

[BIOAP 4130 Histology: The Biology of the Tissues
Spring. 4 credits. Prerequisite: one year introductory biology. Recommended: BIOBM 3300 or 3310, or equivalent. Letter grades only. Next offered 2009–2010. S. Suarez and L. Mizer.
Provides students with a basis for understanding the microscopic, fine-structural, and functional organization of vertebrates (primarily mammals), as well as methods of analytic morphology at the cell and tissue levels. Emphasizes dynamic interrelations of structure, composition, and function in cells and tissues.]

BIOAP 4160 Cell Physiology and Genomics Laboratory
Spring. 4 credits. Limited to 24 students. For pre-med, pre-vet, juniors, seniors, and graduate students interested in biomedical science. Pre- or corequisite: BIOAP 3160 or BIOBM 4320 or permission of instructor. Letter grades only. N. A. Lorr, H.–H. Chuang, and staff.
The course emphasizes the application of molecular biology and analytical methods, including microscopy, to investigation of physiological mechanisms of cellular excitability. Students learn manipulation of nucleic acids including molecular cloning RT-PCR, qRT-PCR and microarray analysis, heterologous expression systems including *Xenopus* oocytes and cultured mammalian cells, characterization of proteins using antibodies, and analysis of ion channels, receptors, and signal transduction pathways by measuring ionic currents and membrane potentials in the *Xenopus* oocyte expression system. Students also learn critical reading of original research articles. Students will conduct an independent project in the latter part of the semester using methods and systems introduced during the course.

[BIOAP 4250 Gamete Physiology and Fertilization (also ANSC 4250)
Fall. 2 credits. Prerequisite: ANSC 2400 or equivalent. Letter grades only. Offered alternate years; next offered 2009–2010. Lec. J. E. Parks.
For description, see ANSC 4250.]

[BIOAP 4270 Fundamentals of Endocrinology (also ANSC 4270)
Fall. 3 credits. Prerequisite: animal or human physiology course or permission of instructor. Letter grades only. Lec. Next offered 2009–2010. P. A. Johnson.
For description, see ANSC 4270.]

BIOAP 4580 Mammalian Physiology
Spring. 3 credits. Auditors allowed. Prerequisite: BIOAP 3110 or equivalent. Recommended for biological sciences majors, pre-med and pre-vet students, and beginning graduate students in physiology, nutrition, and animal science. Letter grades only. Evening prelims. K. W. Beyenbach.
The course offers a treatment of selected topics in vertebrate and human physiology that emphasizes concepts and a working knowledge of physiology. The first course half surveys biological design and the functional strategies of multicellular animals. Topics include mammalian fluid compartments, homeostasis, and membrane and epithelial transport. The second half examines the mechanism and the regulation of cardiovascular, gastrointestinal, and renal systems. Course concluding lectures aim to illustrate the integration of systems in the regulation of acid/base balance. Clinical examples of dysfunction will underscore the role of normal function, and some diseases will be traced to the deepest roots of their molecular etiology. Weekly problem sets count 50 percent of the final grade.

[BIOAP 4750 Mechanisms Underlying Mammalian Developmental Defects (also NS 4750)
Spring. 3 credits. Prerequisites: BIOBM 3300, 3310–3320, or 3330 (may be taken concurrently). S-U or letter grades. Offered alternate years; next offered 2009–2010. D. Noden and P. Stover.
Focuses on the causes of developmental defects and how genetic changes or teratogenic insults disrupt developmental regulatory and metabolic pathways.]

[BIOAP 4890 Mammalian Embryology (also BIOGD 4890)
Spring. 3 credits. Prerequisite: introductory biology. S-U or letter grades. Evening prelims. Offered alternate years; next offered 2009–2010. D. M. Noden.
Examines the early formation of the mammalian body and placenta, emphasizing comparative aspects, and morphogenesis and histogenesis of each organ system.]

BIOAP 4980 Teaching Experience
Fall or spring. 1–4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, upon petition (one time only) to their class dean, carry fewer than 12 other credits and remain in good standing. This would affect Dean's List eligibility but not eligibility for graduating with distinction. S-U or letter grades by permission of the instructor. Staff.
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and assisting in biology courses. This experience may include supervised participation in a discussion group, assisting in a biology laboratory, assisting in field biology, or tutoring.

BIOAP 7140 Cardiac Electrophysiology
Fall. 1 credit. S-U grades only. Offered alternate years. R. Gilmour.
Survey of cardiac potentials, passive membrane properties, ion channels, and cardiac arrhythmias. Emphasizes nonlinear dynamic aspects of cardiac electrophysiology and cardiac arrhythmias.

BIOAP 7150 Animal Welfare
Fall. 1 credit. Prerequisite: BIOAP 3110 or equivalent. S-U or letter grades. Offered alternate years. K. A. Houpt.
Emphasizes stress in domestic animals.

BIOAP 7200 Animal Physiology and Anatomy Seminar
Spring and fall. 1 credit each semester. Prerequisite: admission to graduate field of physiology. S-U or letter grades. R. Davisson.
Designed to train graduate students in the field of physiology to become professional scientists. Students are required to give a seminar on their research. Advice and feedback are provided. Throughout the semester, advice is provided on subjects such as preparation of manuscripts, seminars, and grant proposals.

[BIOAP 7570 Current Concepts in Reproductive Biology
Fall. 3 credits. Limited to 20 students. Prerequisites: undergraduate degree in biology and strong interest in reproductive biology. S-U or letter grades. Offered alternate years; next offered 2009–2010. J. E. Fortune, P. A. Johnson, and staff.
Team-taught survey course in reproductive physiology/endocrinology. Lectures by a number of reproductive biologists on various aspects of male reproductive function (endocrine regulation, testis function, spermatogenesis, sperm physiology/function); female reproductive function (endocrinology, ovarian development and function, oocyte physiology/function); fertilization and gamete transport; pregnancy; parturition; lactation; aging; reproductive technology. Student participation in the form of discussions and/or presentations.]

BIOAP 7940 Special Topics in Physiology
Fall or spring. 1 or 2 credits per topic; may be repeated for credit. Enrollment in each topic may be limited. S-U or letter grades by permission of instructor.
Lectures, laboratories, discussions, and seminars on specialized topics.

Related Courses in Other Departments

Advanced Work in Animal Parasitology (VETMI 7370)

Animal Reproduction and Development (ANSC 3000)

Developmental Biology (BIOGD 3850)

Fundamentals of Endocrinology (ANSC 4270)

Research in Marine Biology (BIOSM 4130)

Sensory Function (BIONB 4920)

Teaching Experience (BIOG 4980)

Undergraduate Research in Biology (BIOG 4990)

BIOCHEMISTRY, MOLECULAR AND CELL BIOLOGY (BIOBM)

BIOBM 1250 Biology Seminar
Fall and spring. 1 credit. Prerequisite: first-year standing or permission of instructor. S-U grades only. Staff.
A first-year seminar designed for students with Biology AP credit or a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

BIOBM 1320 Orientation Lectures in Molecular Biology and Genetics (also BIOGD 1320)
Spring, weeks 1–3. 0 credits. Primarily for freshmen, sophomores, and transfer students. S-U grades only. Lec. J. Blankenship.
Six professors discuss their research and promising new areas for research in the future.

BIOBM 3300–3320 Principles of Biochemistry
Introductory biochemistry is offered in three formats: individualized instruction (3300) and lectures (3310 and 3320) during the academic year, and lectures (3330) during the summer. *Lectures are given fall semester (3310), spring semester (3320), and summer (3330).*

BIOBM 3300 Principles of Biochemistry, Individualized Instruction
Fall or spring. 4 credits. Prerequisites: one year introductory biology and one year general chemistry and CHEM 1570 or 3570–3580 (CHEM 3580 may be taken concurrently) or equivalent, or permission of instructor. Recommended: concurrent registration in BIOBM 3340. May not be taken for credit after BIOBM 3310, 3320, or 3330. S-U or letter grades. Evening prelims: fall, Oct. 2 and Nov. 4; spring, Feb. 19 and March 31. J. E. Blankenship, P. C. Hinkle, and staff.
Fourteen units that cover protein structure and function, enzymes, basic metabolic pathways, DNA, RNA, protein synthesis, and an introduction to gene cloning. No formal lectures, autotutorial format.

BIOBM 3310 Principles of Biochemistry: Proteins and Metabolism
Fall. 3 credits. Prerequisites: one year introductory biology, one year general chemistry, and CHEM 1570 or 3570–3580 (CHEM 1570 or 3570 should not be taken concurrently) or equivalent, or permission of instructor. May not be taken for credit after BIOBM 3300 or 3330. S-U grades by permission of instructor. Lec; evening prelim Oct. 23. G. W. Feigenson.
The chemical reactions important to biology, and the enzymes that catalyze these reactions, are discussed in an integrated lecture format. Topics include protein folding, enzyme catalysis, bioenergetics, and key reactions of synthesis and catabolism.

BIOBM 3320 Principles of Biochemistry: Molecular Biology
Spring. 2 credits. Prerequisites: one year introductory biology and previous or concurrent registration in organic chemistry, or permission of instructor. May not be taken for credit after BIOBM 3300 or 3330. S-U or letter grades by permission of instructor. Lec. B. K. Tye.
Comprehensive course in molecular biology that covers the structure and properties of DNA, DNA replication and repair, synthesis and processing of RNA and proteins, the regulation of gene expression, and the principles and applications of recombinant DNA technologies, genomics, and proteomics.

BIOBM 3330 Principles of Biochemistry: Proteins, Metabolism, and Molecular Biology
Summer, six-week session. 4 credits. Prerequisites: one year introductory biology, one year general chemistry, and CHEM 1570, or 3570–3580, or equivalents, or permission of instructor. May not be taken for credit after BIOBM 3300, 3310, or 3320. S. Ely.
Topics include the structure and function of proteins, enzyme catalysis, metabolism, and the replication and expression of genes.

BIOBM 3340 Computer Graphics and Molecular Biology
Fall or spring. 1 credit. Prerequisite: BIOBM 3330 or 3310–3320 (BIOBM 3320 may be taken concurrently) *or* Corequisite: BIOBM 3300. J. E. Blankenship, P. C. Hinkle, and staff.
Visualization of complex biomolecules using Silicon Graphics computers. Group presentations on current topics in molecular biology.

[BIOBM 3990 Research Practicum in Molecular and Cellular Biology
Fall or spring. 4 credits. Limited to 12 students. Prerequisites: genetics (BIOGD 2810 or biochemistry (BIOBM 3300 or BIOBM 3310 or BIOBM 3320 or BIOBM 3330) and permission of instructor. Lec. Letter grades. M. Inada.
Organizational meeting to schedule open lab times on first day of class. A laboratory course that integrates ongoing faculty research to introduce students to a project-based research environment. Students will engage in the practice of doing science by direct participation in current projects using a variety of experimental methodologies from molecular and cellular biology, biochemistry, genetics, genomics, and computational biology. Students will work in collaborative research groups to approach and solve scientific problems through rigorous inquiry and exchange. Credit may be awarded to a maximum of two consecutive semesters.]

BIOBM 4310 Frontiers in Biophysics
Fall, full day of lec, S, Sept. 13, 9 a.m.–4 p.m., Racker Room, Biotechnology Bldg. 0.5 credit. S-U grades only. G. Feigenson and staff.
Overview of current research in biophysics at Cornell by faculty from different departments across the university. Designed for undergraduates considering a career in biophysics and for graduate students interested in biophysics research opportunities at Cornell.

BIOBM 4320 Survey of Cell Biology
Spring. 3 credits. Prerequisite: BIOBM 3300, 3330, or 3310, and previous or concurrent registration in 3320, or equivalent. Recommended: BIOGD 2810. Lec. Evening prelims Mar. 3 and Apr. 16. V. M. Vogt.
Survey of a wide array of topics focusing on the general properties of eukaryotic cells. Topics include methods used for studying cells, the structure and function of the major cellular organelles, and analyses of cellular processes such as mitosis, endocytosis, cell motility, secretion, cell-to-cell communication, gene expression, and oncogenesis. Some of the material is covered in greater depth in BIOBM 4370, BIOGD 4830, and BIOBM 6320, 6360, and 6390.

BIOBM 4340 Applications of Molecular Biology to Medicine, Agriculture, and Industry
Fall. 3 credits. Prerequisites: BIOBM 3300 or 3330 or 3310/3320. Recommended: BIOBM 4320. S-U or letter grades. Lec. S. Ely.
Lecture topics emphasize transgenic animal and plant systems that constitute marketed or near-market applications such as production of pharmaceuticals in milk, edible and nucleic acid vaccines, gene therapy, and high-tech agricultural products. Additional non-transgenic topics will include cancer treatments and relevant aspects of the human genome projects. An overview of human immunology and its relationship to drug development will be provided. Students will also explore relevant scientific literature.

BIOBM 4350–4360 Undergraduate Biochemistry Seminar
1 credit; may be repeated. Prerequisites: upperclass standing; BIOBM 3300, 3330, or 3310–3320, or written permission of instructor. S-U grades only. D. Wilson.
Selected papers from the literature on a given topic are evaluated critically during 12 one-hour meetings.

BIOBM 4370 Regulation of Cell Proliferation, Senescence, and Death (also BIOGD/TOX 4370)
Spring. Variable credit; students may take lec for 2 credits or lec and disc for 3 credits. Limited to about 20 students per disc; priority given to graduate students. Prerequisite: BIOG 1101–1102 or 1105–1106 and BIOBM 3300 or 3310–3320. Recommended: BIOGD 2810 and BIOBM 4320. S-U or letter grades. S. Lee.
Covers a wide spectrum of issues related to cell proliferation in eukaryotes. Lectures include various aspects of the regulation of cell division cycle and signal transduction pathways, with additional topics on oncogenesis, cell aging, and cell death. The facts as well as concepts and logics behind findings are presented in the lectures. Research articles are analyzed and discussed in depth during discussion section.

BIOBM 4380 The RNA World
Spring. 3 credits. Prerequisites: BIOBM 3300 or 3310/3320 or 3330, or permission of instructor. A. Ke.
Part of the excitement about "the RNA world" stems from the recognition that RNA is ancient and that the evolution of life as we know it depended upon RNA evolving both informational and catalytic capabilities. This course explores these ideas but more generally provides a comprehensive introduction to RNA biology. Many of the most interesting topics in the RNA biology, such as the mechanism of the RNA interference and its widespread applications, will be covered in detail. Other topics require consideration of essential RNA-protein complexes such as ribosomes, spliceosomes, telomerase, and Signal recognition particles. Classical experiments as well as up-to-date research are covered in this course. A portion of each class is devoted to discussion and questions.

BIOBM 4390 Molecular Basis of Human Disease (also BIOGD 4390)
Fall. 3 credits. Prerequisites: biochemistry and molecular biology (e.g., BIOBM 3300, 3310–3320, or 3330) and genetics (e.g., BIOGD 2810) or permission of instructor. Recommended: cell biology (e.g., BIOBM 4320 or BIOAP 3160) and physiology (e.g., BIOAP 3110 or 4580). S-U or letter grades. Lec. W. L. Kraus.
This course examines how changes in the normal expression, structure, and activity of gene products caused by genetic mutations, epigenetic phenomena, and environmental agents lead to human diseases. The material focuses on how these changes lead to alterations in normal cellular processes, as well as the resulting physiological consequences. Topics are selected from hormone insensitivity syndromes, inborn errors of metabolism, gene fusions resulting in hybrid proteins, gene amplification, gene inactivation, disruption of signaling pathways, disruption of metabolic pathways, and the molecular actions of infectious agents and environmental toxins. Examples of diseases are selected to emphasize various aspects of genetics, molecular biology, cell biology, physiology, immunology, and endocrinology that have been presented in other courses. In addition, the methods used to identify the underlying biochemical and genetic basis of the diseases, as well as possible pharmaceutical and genetic therapies for treating the diseases, are presented. A portion of the lecture periods will be devoted to discussion and practice questions.

BIOBM 4400 Laboratory in Biochemistry and Molecular Biology
Fall, spring, or summer (three-week session). 4 credits. Limited enrollment. Priority given to undergraduate biology majors in Biochemistry or Molecular and Cell Biology programs of study and to graduate students with minor in field of biochemistry. Prerequisites: BIOBM 3300 or 3330 or 3310–3320 (at least one of 3310–3320 completed but one may be taken concurrently). S. Ely and H. Nivison.
Experiments related to molecular biology (includes PCR, DNA cloning, hybridization analysis, restriction mapping, and DNA sequence analysis), protein purification and analysis (salt fractionation, ion exchange chromatography, affinity chromatography, SDS-PAGE, and immunoblotting), and determination of enzyme kinetic parameters.

[BIOBM 4430 Experimental Molecular Neurobiology (also BIONB 4300)
Spring. 4 credits. Limited to 12 students. Letter grades only. Disc, lab. Offered alternate years; next offered 2009–2010. D. L. Deitcher.
For description, see BIONB 4300.]

[BIOBM 4500 Principles of Chemical Biology (also CHEM 4550)
Fall. 3 credits. Prerequisites: CHEM 3570–3580 or 3590–3600 or equivalent. Next offered 2009–2010. T. P. Begley.
For description, see CHEM 4550.]

BIOBM 4834 Molecular Aspects of Plant Development I (also BIOPL 4834)
Fall. 1 credit. 12 lec TBA. J. B. Nasrallah.
For description, see BIOPL 4834.

BIOBM 4850 Bacterial Genetics (also BIOMI/BIOGD 4850)
Fall. 2 or 3 credits; optional credit for registered students with permission of instructor to review literature. Prerequisite: BIOGD 2810. Recommended: BIOMI 2900 and BIOBM 3300 or 3310 and 3320 or 3330. Lec. J. E. Peters.
For description, see BIOMI 4850.

BIOBM 4980 Teaching Experience
Fall or spring. 1- 4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, upon petition (one time only) to their class dean, carry fewer than 12 other credits and remain in good standing. This would affect Dean's List eligibility but not eligibility for graduating with distinction. S-U or letter grades by permission of the instructor. Staff.
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and assisting in biology courses. This experience may include supervised participation in a discussion group, assisting in a biology laboratory, assisting in field biology, or tutoring.

BIOBM 6310 Protein Structure, Dynamics, and Function
Fall. 3 credits. Prerequisites: BIOBM 3300 or 3330 or 3310–3320 and organic chemistry. Recommended: physical chemistry course. S-U or letter grades. Lec. L. Nicholson.
Presentations on the basic principles of protein structure, dynamics, and function. Specific topics include protein stability, dynamics, evolution, molecular recognition, basic enzyme kinetics, and spectroscopic tools for studying proteins.

BIOBM 6330 Biosynthesis of Macromolecules
Fall. 2 credits. Prerequisite: BIOBM 3300 or 3330 or 3310–3320. Recommended: BIOGD 2810. Lec. J. W. Roberts and D. B. Wilson.
Synthesis of DNA, RNA, and proteins, and regulation of gene expression.

BIOBM 6360 Functional Organization of Eukaryotic Cells
Spring. 3 credits. Prerequisites: BIOBM 3300 or 3330 or 3310–3320, and 4320, or equivalents. Lec. W. J. Brown.
Aims to provide an integrated view of eukaryotic cell organization as elucidated using biochemical molecular, genetic, and cell biological approaches. Major topics include the cytoskeleton, membrane traffic, and cell

polarity. Together with BIOBM 4370, 632, and 6390 this course provides broad coverage of the cell biology subject area.

BIOBM 6390 The Nucleus
Spring. 2 credits. Prerequisite: BIOBM 3300 or 3330 or 3310–3320, or equivalent. Recommended: BIOGD 2810. Lec. J. T. Lis.
Lectures on topics of eukaryotic genome organization, chromatin structure, regulation of gene expression, RNA processing, the structure and movement of chromosomes, and nuclear export and import. Covers the structure and function of the nucleus at the molecular and cell biological levels.

BIOBM 6410 Laboratory in Plant Molecular Biology (also BIOPL 6410)
Fall. 4 credits. Prerequisites: BIOGD 2810 or equivalent, BIOBM 3300 or 3310 or equivalent, and permission of instructor. S-U grades by permission of instructor. Lab. M. R. Hanson, J. Nasrallah, K. Van Wijk, and staff.
For description, see BIOPL 6410.

[BIOBM 7300 Protein NMR Spectroscopy (also VETMM 7070)
Spring. 2 credits. Prerequisites: CHEM 3890 and 3900, or 2870 and 2880, or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2009–2010. Lec. L. K. Nicholson and R. E. Oswald.
Students acquire the tools necessary for understanding multidimensional NMR of proteins. NMR fundamentals and schemes for magnetization transfer, water suppression, decoupling, and others are presented.]

[BIOBM 7380 Macromolecular Crystallography (also CHEM 7880)
Fall. 3 credits. Prerequisite: permission of instructor. Lec. Next offered 2009–2010. S. E. Ealick.
For description, see CHEM 7880.]

BIOBM 7510 Ethical Issues and Professional Responsibilities
Spring. 1 credit. Prerequisite: graduate students beyond first year. S-U grades only. Organizational meeting first W of semester. Sem. P. Hinkle.
Ethical issues in research and the professional responsibilities of scientists are discussed based on readings and occasional lectures. The topics are intended to cover the requirements for ethical training of graduate students on training grants and follow the recommendations of the Office of Research Integrity.

BIOBM 7940 Current Topics in Biochemistry
Fall or spring. 0.5 or 1 credit for each topic; may be repeated for credit. Prerequisite: BIOBM 3300 or 3330 or 3310–3320 or equivalent. S-U grades only.
Lectures and seminars on specialized topics. Topics for fall and spring to be announced in the course and time roster published at the beginning of each semester or the department mini-courses web site, www.mbg.cornell.edu/cals/mbg/about/courses/mini-courses.cfm.

BIOBM 8300 Biochemistry Seminar
Fall or spring. 0 credits. Prerequisite: graduate students in Biochemistry, Molecular, and Cell Biology. Lec open to everyone. V. Vogt.
Lectures on current research in biochemistry, presented by distinguished visitors and staff members.

BIOBM 8310 Advanced Biochemical Methods I
Fall. 6 credits. Requirement for, and limited to, first-year graduate students in field of biochemistry, molecular, and cell biology. S-U grades only. Lab and disc. Organizational meeting first F of semester 10:10. T. C. Huffaker.
The first half of this course comprises an intensive laboratory covering fundamental aspects of modern molecular biology and cell biology. The second half comprises research in the laboratory of a professor chosen by the student (see BIOBM 8320). Students must enroll separately for each half.

BIOBM 8320 Advanced Biochemical Methods II
Spring. 6 credits. Requirement for, and limited to, first-year graduate students in field of biochemistry, molecular, and cell biology. S-U grades only. Lab. V. Vogt.
Research in the laboratories of two different professors chosen by the student. Arrangements are made jointly between the director of graduate studies and the research advisor.

BIOBM 8330 Research Seminar in Biochemistry
Fall or spring. 1 credit each semester; may be repeated for credit. Requirement for, and limited to, second-, third-, and fourth-year graduate students majoring in field of biochemistry, molecular and cell biology. S-U grades only. W. L. Kraus and V. M. Vogt.
Each student presents one seminar per year on his or her thesis research and then meets with instructors and thesis committee members for evaluation.

BIOBM 8360 Methods and Logic in Biochemistry, Molecular and Cell Biology, Part I
Spring. 1 credit. Prerequisite: first-year graduate students majoring in field of biochemistry, molecular, and cell biology. S-U grades only. Sem and disc. G. P. Hess.
Seminar with critical discussion by students of original research papers selected by faculty members of the field of biochemistry, molecular and cell biology.

BIOBM 8380 Scientific Communication and Quantitation in Biochemistry, Molecular and Cell Biology (BMCB)
Spring. 2 credits. Prerequisite: second-year graduate students majoring in field of biochemistry, molecular and cell biology or field of genetics and development. S-U grades only. D. Shalloway.
Interactive seminar to develop the general skills needed to support a career in scientific research: experimental design, writing scientific papers and grants, oral presentation, basic statistical and computational methods, and managing a research laboratory. Exercises focus on the preparation of a mock research grant proposal.

Related Courses in Other Departments

Lipids (BIOAP 6190, NS 6020)

Teaching Experience (BIOG 4980)

Undergraduate Research in Biology (BIOG 4990)

ECOLOGY AND EVOLUTIONARY BIOLOGY (BIOEE)

BIOEE 1250 Biology Seminar
Fall or spring. 1 credit. Prerequisite: first-year standing or permission of instructor. S-U grades only. Staff.
A first-year seminar designed for students with Biology AP credit or a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

BIOEE 1540 Introductory Oceanography, Lectures (also EAS 1540)
Fall. 3 credits; optional 1-credit laboratory offered as BIOEE/EAS 1550. S-U or letter grades. B. C. Monger.
For description, see EAS 1540.

BIOEE 1550 Introductory Oceanography, Laboratory (also EAS 1550)
Fall. 1 credit. Corequisite: BIOEE/EAS 1540. S-U or letter grades. B. C. Monger.
For description, see EAS 1550.

BIOEE 2070 Evolution (also HIST 2870, STS 2871)
Fall or summer (six-week session). 3 credits. Intended for students with no background in college biology. May not be taken for credit after BIOEE 2780. Does not meet evolutionary biology requirement for biological sciences major. S-U or letter grades. W. B. Provine.
Evolution is the central concept in biology. This course examines evolution in historical and cultural contexts. This course aims to understand the major issues in the history and current status of evolutionary biology and explore the implications of evolution for culture. Issues range from controversies over mechanisms of evolution in natural populations to the conflict between creationists and evolutionists.

BIOEE 2610 Ecology and the Environment
Fall or summer (three-week session). 4 credits. Prerequisite: one year introductory biology. S-U or letter grades. Fall: A. Kessler, C. L. Goodale, and staff. Summer: A. T. Vawter.
Fall: Explores interactions between the environment and organisms in the context of individuals, populations, communities, and ecosystems. Emphasizes basic ecological principles and processes intrinsic to understanding the world around us and in more advanced studies in the environmental sciences, including management-oriented disciplines. Major topics include adaptive strategies of organisms, population dynamics, species interactions, community structure and ecosystem function, biodiversity, biogeochemistry, productivity, human influences on ecosystems, and sustainable practices.

Summer: Introduction to principles of ecology, concerning the interactions between organisms and their environment. Deals with both terrestrial and aquatic ecology, drawing examples from both plant and animal studies. Phenomena that occur at the individual, population, community, and ecosystem levels of organization are examined through classroom lectures and discussion and through a series of lab and field experiences in natural habitats around Ithaca. Ecological principles are applied extensively to current environmental problems and issues.

BIOEE 2630 Field Ecology
Fall. 3 credits. Pre- or corequisite: BIOEE 2610. Letter grades only. One weekend field trip. A. Agrawal.
Field exercises designed to give students direct experience with fieldwork, with emphasis on developing observational skills, journal keeping, and a landscape perspective. Topics include plant succession, niche relationships of insects, influence of herbivores and competition on plant performance, decomposition of soil litter, foraging behavior, census methods, and use of scientific collections.

[BIOEE 2640 Tropical Field Ornithology
Winter, two-week, full-time course. 3 credits. Limited to 12 students; minimum of 8. Prerequisite: permission of instructor. Intended for students with limited or no bird knowledge. S-U or letter grades. Daily fieldwork, disc, reading, and individual project. Next offered 2009–2010. A. A. Dhondt.]

BIOEE 2650 Tropical Field Ecology and Behavior
Winter, field course based in Kenya, Africa. 4 credits. Limited to 15 students. Prerequisites: one introductory biology course and permission of instructors. Letter grades only. I. J. Lovette and D. Rubenstein.
Gives students a broad hands-on understanding of tropical biology, ecology, and behavioral ecology. Students gain experience with experimental design and data collection, field methods, basic statistics, interpretation and evaluation of primary scientific literature, and scientific paper writing. Students pay separately for their international airfare and there may also be a small supplementary laboratory fee.

[BIOEE 2670 Introduction to Conservation Biology
Fall. 3 credits. Intended for both science and nonscience majors. May not be taken for credit after NTRES 4100. Completion of BIOEE 2670 not required for NTRES 4100. S-U or letter grades. One Sat. a.m. field trip. Offered alternate years; next offered 2009–2010. J. W. Fitzpatrick.]

BIOEE 2740 The Vertebrates: Structure, Function, and Evolution
Spring. 4 credits. Prerequisite: one year introductory biology. Fee: $25. S-U or letter grades. K. R. Zamudio.
Introductory course in vertebrate organismal biology that explores the structure and function of vertebrates with an emphasis on trends in vertebrate evolution. Lectures cover topics such as the origin and evolution of various vertebrate groups, sensory systems, thermoregulation, life history, locomotion, feeding, size, and scaling. Laboratories include dissections of preserved vertebrate animals and noninvasive live animal demonstrations.

BIOEE 2780 Evolutionary Biology
Fall or spring. 3 or 4 credits; 4-credit option involves writing component and two disc per week; 4-credit option limited to 20 students per sec each semester. (Students may not preregister for 4-credit option; interested students complete application form on first day of class.) Limited to 300 students. Prerequisite: one year introductory biology or permission of instructor; first-semester freshmen by permission of instructor. S–U or letter grades. One all-day Sat. field trip. Evening prelims: spring, Feb. 26 and Mar. 31. Fall, I. J. Lovette; spring, staff.
Considers explanations for patterns of diversity and for the apparent good fit of organisms to the environment. Topics include the genetic and developmental basis of evolutionary change, processes at the population level, the theory of evolution by natural selection, levels of selection, concepts of fitness and adaptation, modes of speciation, long-term trends in evolution, rates of evolution, and extinction. Students taking the 4-credit option read additional materials from the primary literature and write a series of essays in place of the regular prelims.

[BIOEE 3500 Dynamics of Marine Ecosystems (also EAS 3500)
Fall. 3 credits. Limited to 25 students. Prerequisites: one year of calculus and semester of oceanography (i.e., BIOEE/EAS 1540), or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2009–2010. C. H. Greene and R. W. Howarth.
For description, see EAS 3500.]

BIOEE 3510 Conservation Oceanography (also EAS 3510)
Spring, full-time, three-week course. 4 credits. Limited to 25 students. Prerequisites: enrollment in Cornell Abroad Earth and Environmental Sciences Semester in Hawaii; one semester of calculus and two semesters of biology or permission of instructor. Letter grades only. C. H. Greene, C. D. Harvell, and B. C. Monger.
For description, see EAS 3510.

[BIOEE 3620 Dynamic Models in Biology (also MATH 3620)
Spring. 4 credits. Prerequisites: two semesters introductory biology (BIOG 1101–1102, 1105–1106, 1107–1108, 1109–1110 or equivalent) and completion of mathematics requirements for Biological Sciences major or equivalent. S-U or letter grades. Offered alternate years; next offered 2009–2010. S. P. Ellner and J. M. Guckenheimer.]

BIOEE 3630 Field Methods in Ornithological Research
Summer (eight-week session). 5 credits. Limited to 15 students. Prerequisites: introductory biology or equivalent, interest and ability to spend all day in the field under variable weather conditions, including intense sun and periods of rain, and permission of instructor. S-U or letter grades. D. W. Winkler and staff.
Detailed, hands-on experience with the methods commonly used in ornithological field research, focusing on different methodologies used to obtain data on organismal structure and function, life history characteristics, and behavior. While being immersed in an ongoing, intensive research program in the Ithaca area, students learn about the types of evolutionary and ecological questions that can be addressed through use of different research methodologies, experimental design, and basic statistical analysis techniques.

BIOEE 3690 Chemical Ecology (also BIONB/ENTOM 3690)
Spring. 3 credits. Prerequisites: one semester of introductory biology for majors or nonmajors and one semester of introductory chemistry for majors or nonmajors or equivalents, or permission of instructor. S-U or letter grades. A. Kessler, A. Agrawal, G. Jander, and J. S. Thaler.
Why are chilies so spicy? This course examines the chemical basis of interactions between species and is intended for students with a basic knowledge of chemistry and biology. Focuses on the ecology and chemistry of plants, animals, and microbes. Stresses chemical signals used in diverse ecosystems, using Darwinian natural selection as a framework. Topics include: plant defenses, microbial warfare, communication in marine organisms, and human pheromones.

BIOEE 3710 Human Paleontology (also ANTHR 3710)
Fall. 4 credits. Limited to 18 students. Prerequisite: one year introductory biology or ANTHR 1300 or permission of instructor. Letter grades only. Occasional field trips. K. A. R. Kennedy.
Broad survey of the fossil evidence for human evolution with special attention to skeletal and dental anatomy, geological contexts, paleoecology, dating methods, archaeological associations, and current theories of human origins and physical diversity.

[BIOEE 3730 Biodiversity and Biology of the Marine Invertebrates
Fall (but course must be taken previous summer at Shoals Marine Laboratory [SML]), three-week, full-time course. 5 credits (students enroll for credit during fall semester). Limited to 24 students. Prerequisites: one year introductory biology for majors; permission of faculty because off campus. Letter grades only. Daily and evening lec, lab, and fieldwork. Total cost for room, board, and overhead at SML: $1,200. Offered alternate years; offered 2009–2010. C. D. Harvell.]

[BIOEE 4050 Biology of the Neotropics
Spring. 2 credits. Limited to 18 students. Prerequisite: BIOEE 2610 or permission of instructor. S-U or letter grades. Next offered 2009–2010. A. S. Flecker.]

[BIOEE 4460 Plant Behavior—Induced Plant Responses to Biotic Stresses
Spring. 3 credits. Limited to 12 students. Prerequisite: BIOEE 2610 or permission of instructor. S-U or letter grades. Next offered 2009–2010. A. Kessler.
How do plants respond to herbivore attack? What are the molecular, plant hormonal, metabolic mechanisms of these responses? What ecological consequences do these responses have for the fitness of the plants and their attackers? The course provides an overview of the plant's myriad responses to herbivores and compares them with responses to pathogens. It gives an introduction to the study of induced plant responses in the lectures as well as practical independent and group-intensive work.]

BIOEE 4500 Mammalogy, Lectures
Spring. 3 credits. Recommended: BIOEE 2740. Letter grades; S-U grades by permission only. Offered alternate years. B. A. McGuire.
Lectures cover the evolution, diversity, functional morphology, behavior, ecology, and biogeography of living mammals. Selective coverage of mammalian fossils, conservation status, domestication, and diseases.

BIOEE 4501 Mammalogy, Laboratory
Spring. 1 credit. Limited to 16 students. Pre- or corequisite: BIOEE 4500. Letter grades; S-U grades by permission only. Fee: $20. Travel to Cornell University Museum of Vertebrates (CUMV) at the Laboratory of Ornithology is necessary. One all-day field trip may be scheduled. Offered alternate years. B. A. McGuire.
Laboratory topics include systematics, morphology, reproductive biology, locomotion, and behavior. Focus is on terrestrial mammals of North America. Most laboratories involve studies of skeletons and museum specimens; dissection of preserved material is possible. Live animals may be studied in the field and used in the laboratory for nondestructive experiments and demonstrations.

BIOEE 4530 Speciation
Spring. 4 credits. Limited to 40 students. Prerequisites: BIOEE 2780 and BIOGD 2810 or equivalents, or permission of instructor. S-U or letter grades. Offered alternate years. R. G. Harrison.
Advanced course in evolutionary biology focusing on the pattern and process of speciation and the nature and origin of intrinsic barriers to gene exchange. Lecture topics include species concepts and definitions, the history of ideas about speciation, the biological basis of intrinsic barriers to gene exchange, current models for the origin of such barriers, genetic architecture of speciation, rates of speciation. Emphasis is on developing a rigorous conceptual framework for discussing speciation and on detailed analysis of a series of case histories.

BIOEE 4550 Insect Ecology (also ENTOM 4550)
Fall. 4 credits. Recommended: ENTOM 2120 or BIOEE 2610 or permission of instructor. S-U or letter grades. Offered alternate years. J. S. Thaler.
For description, see ENTOM 4550.

[BIOEE 4560 Stream Ecology (also NTRES 4560)
Fall. 4 credits. Limited to 40 students. Prerequisite: BIOEE 2610 or permission of instructor. S-U or letter grades. Field project with lab papers. One Sat. field trip. Offered alternate years; next offered 2009–2010. A. S. Flecker and C. E. Kraft.
For description, see NTRES 4560.]

[BIOEE 4570 Limnology: Ecology of Lakes, Lectures
Spring. 3 credits. Prerequisite: BIOEE 2610 or written permission of instructor. Recommended: introductory chemistry. Letter grades; S-U grades by permission only. Offered alternate years; next offered 2009–2010. N. G. Hairston, Jr.]

[BIOEE 4571 Limnology: Ecology of Lakes, Laboratory
Spring. 2 credits. Pre- or corequisite: BIOEE 4570. Letter grades; S-U grades by permission only. One weekend field trip. Fee for food on field trip: $15. Offered alternate years; next offered 2009–2010. N. G. Hairston, Jr. and staff.]

[BIOEE 4580 Community Ecology
Spring. 4 credits. Prerequisites: BIOEE 2610, 2780, or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2009–2010. M. A. Geber and A. Agrawal.]

BIOEE 4600 Theoretical Ecology
Spring. 4 credits. Limited enrollment. Prerequisites: completion of Biological Sciences mathematics requirement or equivalent, and either one additional semester of mathematics, statistics, or modeling (e.g., BEE 2600/4530/4750, NTRES 3100/4110, BIONB 4220) or permission of instructor. S-U or letter grades. Offered alternate years. S. P. Ellner.
Introduction to the models used to construct ecological theory and analyze data on ecological dynamics, and to the mathematical and computer methods used to analyze these models. Applications from individual decision-making through multispecies and spatial dynamics introduce the main themes in theoretical ecology: optimization, dynamics, and the links between process and pattern. The lab includes instruction in computer programming and review of mathematical methods.

BIOEE 4620 Marine Ecology (also EAS 4620)
Fall. 3 credits. Limited to 75 students. Prerequisite: BIOEE 2610. Letter grades; S-U grades by permission only. Offered alternate years. C. D. Harvell and C. H. Greene.
Lectures and discussion focus on current research in broad areas of marine ecology with an emphasis on processes unique to marine systems. A synthetic treatment of multiple levels of organization in marine systems including organismal, population, community, ecosystems, and evolutionary biology. Examples are drawn from all types of marine habitats, including polar seas, temperate coastal waters, and tropical coral reefs.

[BIOEE 4640 Macroevolution
Spring. 4 credits. Limited to 35 students. Prerequisite: BIOEE 2780 or permission of instructor. Interested graduate students strongly encouraged to preregister. Letter grades; S-U grades by permission only. Offered alternate years; next offered 2009–2010. A. R. McCune.]

BIOEE 4660 Physiological Plant Ecology, Lectures
Spring. 3 credits. Limited to 30 students. Prerequisite: BIOEE 2610 or introductory plant physiology. Letter grades; S-U grades by permission only. Offered alternate years. J. P. Sparks.
Detailed survey of the physiological approaches used to understand the relationships between plants and their environment. Lectures explore physiological adaptation; limiting factors; resource acquisition and allocation; photosynthesis, carbon, and energy balance; water use and water relations; nutrient relations; linking physiology, development, and morphology; stress physiology; life history and physiology; the evolution of physiological performance; and physiology at the population, community, and ecosystem levels. Readings draw from the primary literature and textbooks.

BIOEE 4661 Physiological Plant Ecology, Laboratory
Spring. 2 credits. Limited to 15 students. Pre- or corequisite: BIOEE 4660. Letter grades only. Offered alternate years. J. P. Sparks.
Detailed survey of the physiological approaches used in understanding the relationships between plants and their environment. Laboratories apply physiological techniques to specific ecological problems and cover aspects of experimental design and computer-aided data analysis. Most laboratories run past the three-hour period, with students spending an average of three hours per week in additional lab time for this course.

BIOEE 4670 Seminar in the History of Biology (also HIST 4150, BSOC/STS 4471)
Fall or summer (six-week session). 4 credits. Limited to 18 students. S-U or letter grades. W. B. Provine.
Specific topics change each year.

[BIOEE 4690 Food, Agriculture, and Society (also BSOC/STS 4691)
Spring. 3 credits. Limited to 20 students. Prerequisite: introductory ecology course or permission of instructor. S-U or letter grades. Next offered 2010–2011. A. G. Power.]

BIOEE 4700 Herpetology, Lectures
Spring. 2 credits. Limited to 50 students. Recommended: BIOEE 2740 and concurrent enrollment in BIOEE 4701. Letter grades; S-U grades by permission only. Offered alternate years. H. W. Greene.
Lectures cover various aspects of the biology of amphibians and reptiles, including evolution, zoogeography, ecology, behavior, and physiology.

BIOEE 4701 Herpetology, Laboratory
Spring. 2 credits. Limited to 35 students. Pre- or corequisite: BIOEE 4700. Letter grades; S-U grades by permission only. Fee: $30. Occasional field trips and special projects. Offered alternate years. H. W. Greene.
Laboratory topics include systematics, morphology, and behavior. Live animals are studied in the field and are used in the laboratory for nondestructive demonstrations and experiments. The systematics laboratory exercises are based on museum specimens and dissection of preserved materials.

BIOEE 4730 Ecology of Agricultural Systems (also HORT 4730)
Fall. 3 credits. Limited to 45 students. Prerequisite: BIOEE 2610 or permission of instructor. S-U or letter grades. During first six weeks of class, Thurs. meetings may run later because of field trips. L. E. Drinkwater.
Analysis of the ecological processes operating in agricultural systems, with an emphasis on understanding relationships between agroecosystem structure and function and interactions among organisms. Examines agroecological theory and research through readings and discussions. The first part of this

course emphasizes understanding biogeochemical processes, population and community ecology with emphasis on plant-herbivore and plant-microbial interactions, and evolutionary processes in agroecosystems. The latter part focuses on the application of ecological knowledge to the design and management of multifunctional agroecosystems. Field trips to local farms and case studies from both the tropics and the temperate zone are used to illustrate important concepts.

[BIOEE 4750 Ornithology
Spring. 4 credits. Limited to 35 students. Prerequisite: permission of instructor by preregistering in E141 Corson Hall. Recommended: BIOEE 2740. Letter grades; S-U grades by permission only. Carpooling to Lab of Ornithology necessary. Fee: $15. Occasional field trips and special projects. Offered alternate years; next offered 2009–2010. D. W. Winkler.]

BIOEE 4760 Biology of Fishes
Fall. 4 credits. Limited to 24 students. Recommended: BIOEE 2740 or equivalent experience in vertebrate zoology. Letter grades; S-U grades by permission only. Small lab fee may be required. Two field trips. Offered alternate years. A. R. McCune.
Introduction to the study of fishes: their structure, physiology and functional morphology, behavior, ecology, diversity, evolution, classification, and identification. Emphasizes marine fishes from different habitats (temperate, tropical coral reef, intertidal, and deep sea); local freshwater species; and interesting freshwater fishes from around the world, especially South America and Africa. Two field trips, including one full-day weekend trip required. Live animals are studied in the field and are sometimes used in the laboratory for nondestructive demonstrations or experiments. The systematics and dissection laboratories use preserved specimens.

[BIOEE 4770 Marine Invertebrates Seminar
Fall. 1 credit. Prerequisite: BIOEE 3730 or permission of instructor. S-U grades only. Offered alternate years; next offered 2009–2010. C. D. Harvell and J. G. Morin.]

BIOEE 4780 Ecosystem Biology
Spring. 4 credits. Prerequisite: BIOEE 2610 or equivalent. S-U or letter grades. Offered alternate years. C. L. Goodale and staff.
Analyzes ecosystems in terms of energy flow and nutrient cycles, emphasizing an experimental approach and comparative aspects of terrestrial, freshwater, and marine ecosystems. Considers anthropogenic effects on ecosystems, such as from acid precipitation and nitrogen pollution. Also analyzes climate change and regional environmental change from an ecosystem perspective.

BIOEE 4790 Paleobiology (also EAS 4790)
Spring. 4 credits. Prerequisites: one year introductory biology for majors and either BIOEE 2740, 3730, or permission of instructor. S-U or letter grades. W. D. Allmon.
For description, see EAS 4790.

BIOEE 4800 Ecological Genetics (also ENTOM 4700)
Spring. 3 credits. Prerequisite: BIOEE 2780. Recommended: introductory course in genetics and/or statistics. S-U or letter grades. B. P. Lazzaro.
For description, see ENTOM 4700.

BIOEE 4900 Topics in Marine Biology
Spring. 2 credits; may be repeated for credit. Limited to 15 students. Prerequisite: permission of instructor. Primarily for undergraduates. S-U or letter grades. Offered alternate years. J. G. Morin and M. J. Shulman.
Seminar courses on selected topics in marine biology; may include laboratory or field trips. Topics and time of organizational meeting are shown in departmental course offerings listed on the web site.

BIOEE 4980 Teaching Experience
Fall or spring. 1–4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, upon petition (one time only) to their class dean, carry fewer than 12 other credits and remain in good standing. This would affect Dean's List eligibility but not eligibility for graduating with distinction. S-U or letter grades by permission of the instructor. Staff.
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and assisting in biology courses. This experience may include supervised participation in a discussion group, assisting in a biology laboratory, assisting in field biology, or tutoring.

BIOEE 6600 Field Studies in Ecology and Evolutionary Biology
Fall or spring. Variable credit. Prerequisites: BIOEE 2610, taxon-oriented course, and permission of instructor. Letter grades; S-U grades by permission only. Lec and field trips TBA. Estimated costs: TBA. Staff.
Provides students with opportunities to learn field techniques and new biota by participating in an intensive series of field exercises. Extended field trips may be scheduled during fall break, intersession, or spring break. The regions visited, trip objectives, and other details are announced by the various instructors at an organizational meeting held at the beginning of the semester. Meetings on campus are devoted to orientation and reports on completed projects.

BIOEE 6601 Tropical Field Ecology
Spring. 2 credits. Prerequisite: for undergraduates, experience or course work with terrestrial, marine, or freshwater organisms. Extended field trip over winter break. Letter grades only. Fee to cover transportation and housing: TBA. Offered alternate years. C. D. Harvell, J. P. Sparks, and N. G. Hairston, Jr.
Field trip to the big island of Hawaii, the Yucatan Coast of Mexico, or similar environment; check with instructors for planned location. Students employ experimental approaches to study ecological and evolutionary questions across a range of tropical biomes.

[BIOEE 6602 Graduate Field Course in Ecology
Spring. 3 credits. Prerequisite: graduate standing. Letter grades only. Fee charged to help cover food and lodging for trip to Florida. Offered alternate years; next offered 2009–2010. J. P. Sparks.]

BIOEE 6610–6611 Environmental Policy (also ALS 6610–6611, BSOC 4611–4612)
6610, fall; 6611, spring. 3 credits each semester; students must register for 6 credits each semester since R grade given at end of fall semester. Limited to 12 students. Prerequisite: permission of instructor. Letter grades only. D. Pimentel.
Focuses on complex environmental issues. Ten to 12 students, representing several disciplines, investigate significant environmental problems. The research team spends two semesters preparing a scientific report for publication in *Science* or *BioScience*. Thus far, every study has been published.

[BIOEE 6680 Principles of Biogeochemistry
Spring. 4 credits. Limited to 20 students. Prerequisite: solid background in ecology, environmental chemistry, or related environmental science; for undergraduates, permission of instructor. S-U or letter grades. Offered alternate years; next offered 2009–2010. R. W. Howarth and C. L. Goodale.]

[BIOEE 6710 Palaeoanthropology of South Asia (also ANTHR 6371, ASIAN 6671)
Fall. 3 credits. Limited to 15 students. Letter grades only. Next offered 2009–2010. K. A. R. Kennedy.]

[BIOEE 6730 Human Evolution: Concepts, History, and Theory (also ANTHR 6373)
Spring. 3 credits. Prerequisite: one year introductory biology or ANTHR 1300 or permission of instructor. Letter grades only. Next offered 2009–2010. K. A. R. Kennedy.]

[BIOEE 6750 Current Topics in Plant Molecular Ecology
Fall. 1 credit; may be repeated for credit. Limited to 20 students. Prerequisite: graduate standing or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2009–2010. A. Kessler.]

BIOEE 7600 Special Topics in Evolution and Ecology
Fall or spring. 1–3 credits; may be repeated for credit. Limited enrollment. Letter grades; S-U grades by permission only. Staff.
Independent or group-intensive study of special topics of current interest. Content varies each semester.

BIOEE 7610 Microsatellite DNA: Techniques
Fall. 1 credit; may be repeated for credit. Limited to 12 students. Prerequisite: permission of instructor. Primarily for graduate students; undergraduates admitted only under exceptional circumstances. E-mail S. M. Bogdanowicz (smb31) by end of Aug. if interested. S-U grades only. Fee: TBA. R. G. Harrison and S. M. Bogdanowicz.

Construct and screen genomic DNA libraries for microsatellite loci. Lectures and group discussions regarding microsatellite isolation, characterization, and evolution. Informal presentations of student research projects.

BIOEE 7640 Plant-Insect Interactions Seminar
Fall or spring. 1 credit; may be repeated for credit. Prerequisite: for undergraduates, permission of instructor. S-U grades only. A. Agrawal, J. S. Thaler, and A. Kessler.
Group-intensive study of current research in plant-insect interactions. Topics vary from semester to semester, but include: chemical defense, coevolution, insect community structure, population regulation, biocontrol, tritrophic interactions, and mutualism.

BIOEE 7670 Current Topics in Ecology and Evolutionary Biology
Fall. 4 credits. Prerequisite: for undergraduates, permission of instructor. S-U grades only. P. P. Feeny.
Critical evaluation and discussion of theory and research in ecology and evolutionary biology. Lectures by faculty and student-led discussions of topics in areas of current importance.

BIOEE 7700 Workshop in Biogeochemistry
Fall or spring. 1–3 credits; may be repeated for credit. Limited to 15 students. Prerequisite: BIOEE 6680. S-U grades only. Staff.
Workshop-forum in which graduate students interact with invited world leaders in biogeochemistry. Workshop topics change each semester. A one-week workshop is preceded by seven one-hour preparatory discussions of readings.

BIOEE 7800 Graduate Seminar in Ornithology (also NTRES 7800)
Fall or spring. 1 credit; may be repeated for credit. Prerequisite: for undergraduates, permission of instructor. S-U grades only. I. J. Lovette, A. A. Dhondt, D. W. Winkler, and J. L. Dickinson.
Group intensive study of current research in ornithology. Topics vary from semester to semester.

BIOEE 8990 M.S. Thesis Research
Fall or spring. 1–15 credits. Prerequisite: admission to field of ecology and evolutionary biology. S-U or letter grades. E&EB field faculty.
Thesis research conducted by an M.S. student in the field of ecology and evolutionary biology with advice and consultation of a major professor who is a member of the field.

BIOEE 9990 Ph.D. Dissertation Research
Fall or spring. 1–15 credits. Prerequisite: admission to field of ecology and evolutionary biology as Ph.D. student. S-U or letter grades. E&EB field faculty.
Dissertation research conducted by a Ph.D. student in the field of ecology and evolutionary biology with advice and consultation of a major professor who is a member of the field.

Related Courses in Other Departments

Ethics and the Environment (BSOC/STS 2061, PHIL 2460)

Physical Hydrology for Ecosystems (BEE 3710)

Evolution of the Earth and Life (BIOG 1700, EAS 1102)

General Microbiology, Lectures (BIOMI 2900)

Prokaryotic Diversity (BIOMI 4140)

Microbial Ecology (BIOMI 4180)

Neurobiology and Behavior I: Introduction to Behavior (BIONB 2210)

Methods in Animal Behavior (BIONB 3230)

Insect Behavior (BIONB/ENTOM 3250)

Ecology of Animal Behavior (BIONB/BIOSM 3290)

Modeling Behavioral Evolution (BIONB 4220)

Animal Communication (BIONB 4260)

Animal Social Behavior (BIONB 4270)

Introductory Botany (BIOPL 2410)

Taxonomy of Vascular Plants (BIOPL 2480)

Phylogenetic Systematics (BIOPL/ENTOM 4400)

Molecular Systematics (BIOPL 4470)

Plant Evolution and the Fossil Record (BIOPL 4480)

Principles and Practice of Historical Biogeography (BIOPL/ENTOM 4530)

Field Ornithology (BIOSM 3740)

Field Marine Biology and Ecology (FMBE) (BIOSM 3750)

Seaweeds, Plankton, and Seagrass: The Ecology and Systematics of Marine Plants (BIOSM 4490)

Biological Statistics I (BTRY/STBTRY 3010, NTRES 3130)

Statistical Genomics (BTRY/STBTRY 4820)

Statistical Analysis of Qualitative Data (BTRY 6030, ILRST 4110)

Soil Science (CSS 2600)

Geographic Information Systems (CSS 4200)

Practicum in Forest Farming as an Agroforestry System (CSS/HORT/NTRES 4260)

Soil Ecology (CSS/HORT 4660)

Introductory Geological Sciences (To Know Earth) (EAS 1101)

Evolution of the Earth System (EAS 3010)

Introduction to Biogeochemistry (EAS/NTRES 3030)

Insect Biology (ENTOM 2120)

Insect Phylogeny and Evolution (ENTOM 3310)

Maggots, Grubs, and Cutworms: Larval Insect Biology (ENTOM 3330)

Techniques of Multivariate Analysis (ILRST 4100)

Human Biology and Evolution (NS/ANTHR 2750)

Environmental Conservation (NTRES 2010)

Applied Population Ecology (NTRES 3100)

Global Ecology and Management (NTRES 3220)

Forest Ecology (NTRES 4200)

Forest Ecology, Laboratory (NTRES 4201)

Wetland Ecology and Management, Lec/Lab (NTRES 4220/4221)

Fungi (PLPA 3090)

GENETICS AND DEVELOPMENT (BIOGD)

BIOGD 1250 Biology Seminar
Fall and spring. 1 credit. Prerequisite: first-year standing or permission of instructor. S-U grades only. Staff.
A first-year seminar designed for students with Biology AP credit or a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

BIOGD 1320 Orientation Lectures in Molecular Biology and Genetics (also BIOBM 1320)
Spring, weeks 1–3. 0 credits. Primarily for freshmen, sophomores, and transfer students. S-U grades only. Lec. J. Blankenship.
For description, see BIOBM 1320.

BIOGD 2800 Lectures in Genetics
Fall, spring, or summer (eight-week session). 3 credits. Lec component of BIOGD 2810. Not open to students majoring in biological sciences; may not be used to fulfill requirements for biological sciences major. Prerequisites: one year introductory biology or equivalent, or permission of instructor. Lec. Highly recommended: problem-solving sessions. T. D. Fox, R. J. MacIntyre, and D. Nero.
For description, see BIOGD 2810.

BIOGD 2810 Genetics
Fall, spring, or summer (eight-week session). 5 credits. Not open to freshmen fall semester. Prerequisite: one year introductory biology or equivalent. Lec, lab. Highly recommended: problem-solving sessions. T. D. Fox, R. J. MacIntyre, and D. Nero.
General introduction to the fundamental principles of genetics in eukaryotes and prokaryotes. Topics include gene transmission, linkage, recombination, structure, mutations, and manipulation, as well as analysis of genomes in individuals and populations.

BIOGD 2820 Human Genetics
Spring. 2 or 3 credits; 2 credits if taken after BIOGD 2810. Prerequisite: one year introductory biology or equivalent. S-U or letter grades. Lec. M. L. Goldberg.
Designed for nonmajors. Lectures provide the technical background needed to understand controversial personal, social, and legal implications of modern genetics that are discussed in section meetings.

BIOGD 3850 Developmental Biology
Fall. 3 credits. Prerequisite: BIOGD 2810. Lec. K. Liu.
Introduction to the morphogenetic, molecular and cellular, and genetic aspects of the developmental biology of animals.

BIOGD 3940 Circadian Rhythms (also ENTOM/BIONB/PLPA 3940)
Fall. 2–3 credits. Prerequisite: ENTOM 2120 or BIOGD 2810 or BIONB 2210 or 2220 or permission of instructor. S-U or letter grades. Lec. K. Lee.
This course will explore a fundamental feature of living organisms found in all kingdoms: how the cellular 24-hour biological clock operates and influences the biological activities. The course will cover fundamental properties of biological rhythms and cellular and molecular structure of circadian oscillators of model organisms including cyanobacteria, fungi, insects, plants, and mammals. One-credit (optional) lab module offered in conjunction with lec.

[BIOGD 3990 Research Practicum in Molecular and Cellular Biology
Fall or spring. 4 credits. Limited to 12 students. Prerequisites: genetics (BIOGD 2810) or biochemistry (BIOBM 3300 or BIOBM 3310 or BIOBM 3320 or BIOBM 3330) and permission of instructor. Lec. Letter grades. M. Inada.
Organizational meeting to schedule open lab times on first day of class. A laboratory course that integrates ongoing faculty research to introduce students to a project-based research environment. Students will engage in the practice of doing science by direct participation in current projects using a variety of experimental methodologies from molecular and cellular biology, biochemistry, genetics, genomics, and computational biology. Students will work in collaborative research groups to approach and solve scientific problems through rigorous inquiry and exchange. Credit may be awarded to a maximum of two consecutive semesters.]

BIOGD 4000 Genomics
Fall. 3 credits. Prerequisites: one year introductory biology plus BIOGD 2810 or 3300 or 3330 or 3310/3320 or permission of instructor. S-U or letter grades. Lec. J. Schimenti.
Introduction to principles underlying the organization of genomes and the methods of studying them, emphasizing genome-wide approaches to research. Covers the application of genomics methodologies for addressing issues including gene regulation, evolution, complex systems, genetics and gene: phenotype relationships. Landmark and timely genomics papers and other research developments will be discussed. Basic bioinformatics tools will be incorporated.

BIOGD 4010 Genomic Analysis
Spring. 3 credits. Prerequisites: BIOGD 4000 or permission of instructor. Lec. T. P. O'Brien.
Overview of approaches and tools used in genomics research. Covers experimental and computational technologies as well as theoretical concepts important for the study of genomes and their function. Topics include genome sequencing and assembly, high-throughput sequencing, comparative genomics, genetic variation and complex traits, expression profiling and proteomics, genome modification and transgenesis, modeling network structure and dynamics. Discussions will explore how genomic tools and approaches can be integrated to study biological systems..

BIOGD 4370 Regulation of Cell Proliferation, Senescence, and Death (also BIOBM/TOX 4370)
Spring. Variable credit; students may take lec for 2 credits or lec and disc for 3 credits. Limited to about 20 students per disc; priority given to graduate students. Prerequisites: BIOG 1101–1102 and BIOBM 3300 or 3310/3320. Recommended: BIOGD 2810 and BIOBM 4320. S-U or letter grades. S. Lee.
For description, see BIOBM 4370.

BIOGD 4390 Molecular Basis of Human Disease (also BIOBM 4390)
Fall. 3 credits. Prerequisites: biochemistry and molecular biology (e.g., BIOBM 3300, 3310/3320, or 3330) and genetics (e.g., BIOGD 2810) or permission of instructor. Recommended: cell biology (e.g., BIOBM 4320 or BIOAP 3160) and physiology (e.g., BIOAP 3110 or 4580). S-U or letter grades. Lec. W. L. Kraus.
For description, see BIOBM 4390.

BIOGD 4400 Stem Cell Biology: Basic Science and Clinical Applications
Spring. 3 credits. Limited to 30 students. Prerequisites: BIOBM 4320 or BIOGD 3850 or permission of instructor. S-U grades by permission of instructor. Lec, disc. T. Tumbar.
This course will cover basic aspects of tissue morphogenesis and homeostasis with emphasis on the biological role of embryonic and adult stem cells in development, and their possible clinical applications. The focus will be placed on mouse and human stem cells. The discussion will be structured around relevant research papers that allow more in-depth analysis of the material taught during lectures.

BIOGD 4500 Vertebrate Development
Fall. 3 credits. Prerequisites: BIOGD 2810, and either BIOBM 4320 or BIOGD 3850. S-U or letter grades. M. J. Garcia-Garcia.
This course explores the developmental mechanisms employed by vertebrate organisms. Topics include the detailed analysis of the genetic, molecular, and cellular events underlying development in frogs, fish, mice, and humans. Course readings include original research articles. Students are encouraged to participate in class discussions.

BIOGD 4610 Development and Evolution
Spring. 3 credits. Prerequisites: BIOEE 2780, BIOGD 2810, BIOBM 3320 or 3300 or 3330. Recommended: BIOGD 3850. Lec. Offered alternate years. M. Wolfner.
This course explores the molecular and genetic pathways and mechanisms that regulate animal development, and how they are modified through evolution to result in the dazzling array of forms and functions seen in the animal kingdom.

BIOGD 4810 Population Genetics
Fall. 4 credits. Prerequisite: BIOGD 2810, BIOEE 2780, or equivalents. Lec, disc. C. F. Aquadro.
Population genetics is the study of the transmission of genetic variation through time and space. This course explores how to quantify this variation, what the distribution of variation tells us about the structure of natural populations, and about the processes that lead to evolution. Topics include the diversity and measurement of genetic variation, mating and reproductive systems, selection and fitness, genetic drift, migration and population structure, mutation, multilocus models, the genetics of speciation, quantitative traits, and the maintenance of molecular variation. Emphasis is placed on DNA sequence variation and the interplay between theory and the data from experiments and natural populations. Specific case studies include the population genetic issues involved in DNA fingerprinting, the genetic structure and evolution of natural and domesticated populations, and the study of adaptation at the molecular level. Examples are drawn from studies of animals, plants, and microbes.

BIOGD 4820 Human Genetics and Society
Fall. 4 credits. Limited to 24 students. Prerequisite: biological sciences majors; priority given to seniors studying genetics and molecular and cell biology and biochemistry; BIOGD 2810 and BIOBM 3300 or 3330 or 3310 and 3320. M. Inada.
Presentation of some of the science and technology of human genetics, plus discussion of the ethical, social, and legal implications of recent advances in the field. Topics include assisted reproductive strategies, eugenics, genetic counseling, genetic screening (pre-implantation, prenatal, neonatal, pre-symptomatic, carrier, and workplace), wrongful life and wrongful birth, genetic effects of abused substances, genetics and behavior, human cloning, forensic uses of genetics, and therapy for genetic diseases. Students lead some discussions. There is a major writing component to the course.

BIOGD 4825 Molecular Biology of Plant Organelles (also BIOPL 4825)
Spring. 1 credit. Prerequisites: BIOPL 4831 or BIOGD 2810 and permission of instructor. S-U or letter grades. M. R. Hanson and D. B. Stern.
For description, see BIOPL 4825.

BIOGD 4840 Molecular Evolution
Spring. 3 credits. Prerequisites: BIOGD 2810. Lec. D. Barbash.
Explores the various processes by which DNA and protein sequences evolve over time, and how this evolution at the molecular level relates to changes in the morphology, behavior, and physiology of organisms that have occurred over time scales ranging from thousands to billions of years. After developing basic principles the course discusses the evolution and organization of genomes from microbes to higher eukaryotes including humans, and the relationship between molecular evolution at the sequence level and the evolution of developmental pathways and systems.

BIOGD 4850 Bacterial Genetics (also BIOMI/BIOBM 4850)
Fall. 2 or 3 credits; optional 1 credit for registered students with permission of instructor to review literature. Prerequisite: BIOGD 2810. Recommended: BIOMI 2900 and BIOBM 3300 or 3310 and 3320 or 3330. J. E. Peters.
For description, see BIOMI 4850.

BIOGD 4860 Eukaryotic Genetics
Spring. 4 credits. Enrollment may be limited to 50 students. Prerequisites: BIOGD 2810, BIOBM 3300 or 3330 or 3310 and 3320. S-U or letter grades. E. E. Alani.
Develops fundamental skills in eukaryotic genetic analysis through lectures and by reading, analyzing, and presenting research articles. Concepts are presented within the context of a well-studied field, such as chromosome segregation. The basic tools that have been developed to study this field are used to analyze other topics such as vegetative and meiotic cell cycle control, embryonic development, pathogen resistance in plants, and human genetics.

BIOGD 4870 Human Genomics
Fall. 3 credits. Prerequisite: BIOGD 2810. Lec. A. G. Clark.
Applies fundamental concepts of transmission, population, and molecular genetics to the problem of determining the degree to which familial clustering of diseases in humans has a genetic basis. Emphasizes the role of full genome knowledge in expediting this process of gene discovery. Stresses the role of statistical inference in interpreting genomic information. Population genetics, and the central role of understanding variation in the human genome in mediating variation in disease risk, are explored in depth. Methods such as homozygosity mapping, linkage disequilibrium mapping, and admixture mapping are examined. The format is a series of lectures with classroom discussion. Assignments include a series of problem sets and a term paper.

BIOGD 4890 Mammalian Embryology (also BIOAP 4890)
Spring. 3 credits. Prerequisite: introductory biology. Offered alternate years; next offered 2009–2010. D. M. Noden.
Examines the early formation of the mammalian body and placenta, emphasizing comparative aspects, and morphogenesis and histogenesis of each organ system.

BIOGD 4900 Manipulating the Mouse Genome (also NS 4900)
Fall. 2 credits. Course meets during first half of semester (R 1:25–3:20; Aug. 23–Oct. 4) and provides background information for VTBMS 7010/TOX 7010 Mouse Pathology and Transgenesis, which meets during second half. Students interested in both courses must register for them separately. Prerequisites: BIOGD 2810 and BIOBM 3300, 3320, or 3330 or NS 3200. Letter grades only. P. D. Soloway.
Functional genomic analysis has benefited enormously from experimental manipulation of the genomes of many organisms. The mouse has been the model of choice for such studies in mammals. This course explores the tools available for experimental manipulation of the mouse genome, including transgenesis, gene targeting, gene trapping, chemical mutagenesis, and cloning by nuclear transplant. Also discussed are use of recombinant inbred mice for complex trait analysis. Readings from the scientific literature focus on seminal applications of these methods.

BIOGD 6080 Epigenetics (also NS 6080)
Fall. 2 credits. Prerequisites: BIOGD 2810 and BIOBM 3300, 3320, or 3330 or NS 3200. Letter grades only. Planned W F 11:15–12:05; occasional evening meetings for student presentations. P. D. Soloway.
Epigenetic effects refer to reversible alterations in chromatin structure that can stably and heritably influence gene expression. These changes include covalent modifications to DNA itself or to proteins bound to DNA as well as noncovalent remodeling of chromatin. This course examines selected epigenetic phenomena described in several eukaryotes, mechanisms regulating these effects, and their phenotypic consequences when normal regulation is lost. Reading materials are from current literature, and participation in class discussion is required.

BIOGD 6100 Genomes as Chromosomes
Fall. 3 credits. Limited to 15 students. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3330 or 3310/332 or equivalent by permission of instructor. Letter grades only. Offered alternate years. T. P. O'Brien and P. E. Cohen.
The eukaryotic genome is partitioned into discrete structural units, the chromosomes. The course examines how chromosome organization is related to chromatin structure, gene expression, DNA replication, repair and stability. Special emphasis is placed on how the linear arrangement of sequence features along the chromosome, such as genes and regulatory modules, relate to the functional organization of the genome in the nucleus. Experimental and computational approaches used to address chromosome structure and function are studied.

[BIOGD 6110 Genome Maintenance Mechanisms
Fall. 1 credit. Meets only during second half of semester beginning Oct. 15. Limited to 25 students. Prerequisites: BIOGD 2810, as well as BIOBM 3300, or 3330, or 3310/3320 (or equivalents). S-U or letter grades. Next offered 2009–2010. R. Weiss.
The course focuses on the molecular mechanisms utilized by eukaryotic cells to preserve genomic integrity. Topics to be discussed include endogenous and exogenous sources of mutation, DNA repair pathways, and cell cycle checkpoint mechanisms. Also addressed will be how genome maintenance impacts genome plasticity and evolution, as well as the relationship between genomic instability and disease, especially cancer.]

[BIOGD 6120 Overview of Model Genetic Organisms
Spring, 2nd 6 weeks of semester. 1 credit. Limited to 20 students. Prerequisites: BIOGD 2810 or 4000 or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2009–2010. J. Schimenti and staff.
Presents the features of various model organisms and their relative merits for conducting various types of genomics/genetics research. Model systems discussed include: yeast, *Arabidopsis, Drosophila, C. elegans*, zebrafish, and mice.]

BIOGD 6130 Genomics and Society
Spring, weeks 10–13. 1 credit. Prerequisite: BIOGD 2810 or BIOGD 4000 or permission of instructor. S-U or letter grades. Disc. S. Kresovich and S. Tanksley.
A multidisciplinary examination of four to six selected topics that relate to the applications of biological insights derived from genomic analysis. Technical, scientific, ethical, political, legal, and/or social aspects of each topic will be considered from various perspectives.

BIOGD 6200 Evolutionary Genomics of Bacteria
Spring. 1 credit. M. Stanhope.
Comparative genomics of bacteria is a valuable approach to deriving information on pathogenesis, antibiotic resistance, host adaptation, and genome evolution. This course provides an evolutionary perspective on comparative bacterial genomics, focusing in particular on pathogens of human and agricultural importance. The course will include lectures, discussion of relevant scientific literature, and a bioinformatics session.

BIOGD 6380 Filamentous Fungal Genomics and Development (also PLPA 6380)
Spring, last four weeks of semester. 1 credit. S-U or letter grades. Prerequisite: BIOGD 2810 or equivalent, or permission of instructor. Lec. Offered alternate years. B. G. Turgeon.
For description, see PLPA 6380.

[BIOGD 6820 Fertilization and the Early Embryo
Spring. 2 credits. Prerequisites: BIOGD 2810; BIOBM 3320, 3300 or 3330; and BIOGD 3850 or permission of instructor. Lec. Offered alternate years; next offered 2009–2010. M. F. Wolfner.
We explore the latest molecular/cell/genetic findings about the biology of gametes, fertilization and early development—and their application to fertility modulation, "cloning" and stem cells.]

BIOGD 6870 Developmental Genetics
Fall. 2 credits. Limited to 20 students. Prerequisites: BIOGD 2810 and 3850 or equivalents. S-U or letter grades. Lec TBA. Offered alternate years. K. J. Kemphues.
Course focuses on methods of genetic analysis of fruitflies, nematodes, mice, and fish to understand mechanisms of development. No text. Lectures and problems from literature.

[BIOGD 6890 Cellular Basis of Development
Fall. 2 credits. Limited to 20 students. Prerequisites: BIOGD 2810, 3850, and either BIOBM 3300 or 3310–3320. Lec. S-U or letter grades. Next offered 2010–2011. J. Liu.
Focuses on the integration of different cellular processes in various developmental contexts. Topics include cell polarity, cell migration, cell adhesion and fusion, cell growth and proliferation, cell-cell communication, and cell death. Students are required to read current literature and participate in discussions in class.]

BIOGD 7800 Current Topics in Genetics and Development
Fall or spring. 1 credit; may be repeated for credit. Limited to 20 students. Primarily for graduate students; priority given to majors in field of genetics. Prerequisite: for undergraduates, written permission of instructor. No auditors. S-U grades only, by permission of instructor. Seminar TBA. Staff.

BIOGD 7810 Problems in Genetics and Development
Fall. 2 credits. Prerequisite: first-year graduate students in field of genetics and development. Disc TBA. Staff.
Introduction to the research literature in selected areas through weekly problem sets and discussions.

BIOGD 7820–7830 Current Genetics/ Development Topics
Spring. 0.5 or 1 credit for each topic; may be repeated for credit. S-U grades only. Lec and sem on specialized topics. Staff.

BIOGD 7840 Introduction to Quantitative Analysis
Fall. 1 credit. Letter grades only. E. Alani (organizer), A. Clark, C. Bustamante, and M. Goldberg.
The goal of this course is to introduce bioinformatic and probability/statistical tools at an intuitive level that will be meaningful to first-year graduate students in Genetics and Development.

BIOGD 7860 Research Seminar in Genetics and Development
Fall and spring. 1 credit. Requirement for, and limited to second-year and beyond graduate students in genetics and development. S-U grades only. Staff.
Each graduate student presents one seminar per year based on his or her thesis research. The student then meets with the thesis committee members for an evaluation of the presentation.

BIOGD 7870 Seminar in Genetics and Development
Fall and spring. 1 credit. Prerequisite: graduate students in Genetics and Development. S-U grades only. Sem, TBA. Staff.
Seminars in current research in genetics and developmental biology conducted by distinguished visitors and staff.

Related Courses in Other Departments

Advanced Plant Genetics (PLBR 6060)

Biosynthesis of Macromolecules (BIOBM 6330)

Concepts and Techniques in Plant Molecular Biology (BIOPL 4831)

Current Topics in Biochemistry (BIOBM 7940)

Evolutionary Biology (BIOEE 2780)

Laboratory in Molecular Biology and Genetic Engineering of Plants (BIOPL 3470)

Laboratory in Plant Molecular Biology (BIOPL 6410)

Light Signal Transduction in Plants (BIOPL 4829)

Molecular Aspects of Plant Development (BIOPL 4834)

Molecular Biology and Genetic Engineering of Plants (BIOPL 3430)

Molecular Biology of Plant Organelles (BIOPL 4825)

Molecular Breeding (BIOPL 4835)

Molecular Plant-Microbe Interactions (BIOPL 4823)

Molecular Plant-Pathogen Interactions I and II (BIOPL 4821–4822)

Plant Biotechnology (BIOPL 4826)

Plant Cell Walls: Structure to Proteome (BIOPL 4827)

Plant Cytogenetics (PLBR 4460)

Plant Gene Evolution and Phylogeny (BIOPL 4824)

Plant Genome Organization (PLBR/BIOPL 4833)

Plant Imaging (BIOPL 4828)

Plant Senescence (BIOPL 4836)

Proteomics in Plant Biology (BIOPL 4832)

The Nucleus (BIOBM 6390)

Undergraduate Research in Biology (BIOG 4990)

Molecular Neurobiology BIONB 4200/7200 (also BIOBM 4350/7940)

MICROBIOLOGY (BIOMI)

BIOMI 1250 Biology Seminar
Fall and spring. 1 credit. Prerequisite: first-year standing or permission of instructor. S-U grades only. Staff.
A first-year seminar designed for students with Biology AP credit or a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

BIOMI 1720 Bioscientific Terminology
Summer and winter. 3 credits. Letter grades only.

BIOMI 2900 General Microbiology Lectures
Fall, spring, or summer (six-week session). 3 credits. Prerequisites: one year introductory biology for majors and one year college chemistry, or equivalent. Highly recommended: concurrent registration in BIOMI 2910. W. C. Ghiorse.
Comprehensive overview of the biology of microorganisms, with emphasis on bacteria. Topics include microbial cell structure and function, physiology, metabolism, genetics, diversity, and ecology. Some material may overlap with BIOGD 2810 and BIOBM 3300. Also covers applied aspects of microbiology such as biotechnology, the role of microorganisms in environmental processes, and medical microbiology. 4-credit option involves one discussion per week led by faculty in the Department of Microbiology and will involve readings and a writing assignment. Students may not pre-register for 4-credit option: Interested students complete an application form on first day of class (enrollment will be limited to 20 students).

BIOMI 2910 General Microbiology Laboratory
Summer (six-week session). 2 credits. Pre- or corequisite: BIOMI 2900. S. M. Merkel.
Study of the basic principles and techniques of laboratory practice in microbiology, and fundamentals necessary for further work in the subject.

BIOMI 2911 General Microbiology Laboratory
Fall or spring. 2 credits. Pre- or corequisite: BIOMI 2900. S. M. Merkel.
Study of the basic principles and techniques of laboratory practice in microbiology, and fundamentals necessary for further work in the subject.

BIOMI 2920 General Microbiology Discussion
Spring. 1 credit. Pre- or corequisite: BIOMI 2900. S-U grades only. Staff.
Series of discussion groups in specialized areas of microbiology to complement BIOMI 2900.

BIOMI 3310 General Parasitology (also VETMI 3310)
Spring. 2 credits. Prerequisites: one year introductory biology. D. Bowman.
Introduction to the basic animal parasites, stressing systematics, taxonomy, general biology, ecological interactions, and behavior of nonmedically important groups. Introduces the major animal parasites: protozoan, nematode, platyhelminth, acanthocephalan, annelid, and arthropod.

BIOMI 3910 Advanced Microbiology Laboratory
Fall. 3 credits. Prerequisites: BIOMI 2900, 2910, and BIOBM 3300 or 3310 or 3330. Priority given to biological sciences students in microbiology program of study. W. C. Ghiorse, J. P. Shapleigh, and S. H. Zinder.
Illustrates basic principles of experimental microbiology. The course is organized into four modules that last three weeks each: (1) ecology, (2) physiology, (3) genetics, and (4) structure and function. Students are encouraged to take this course during their third year of study.

BIOMI 3940 Applied and Food Microbiology (also FDSC 3940)
Fall. 2–3 credits. Prerequisites: BIOMI 2900–2910. C. A. Batt.
For description, see FDSC 3940.

BIOMI 3970 Environmental Microbiology (also CSS 3970)
Spring. 3 credits. Prerequisites: BIOEE 2610 or BIOMI 2900 or CSS 2600 or permission of instructor. Offered alternate odd-numbered years. E. L. Madsen.
Discusses the biological properties, evolution, and behavior of microorganisms in natural systems in relation to past and present environmental conditions on Earth. Also considers the functional role of microorganisms in ecologically and environmentally significant processes through discussion of specific topics such as nutrient and toxic elemental cycles, transformation of pollutant chemicals, wastewater treatment, environmental biotechnology, and astrobiology.

[BIOMI 4040 Pathogenic Bacteriology and Mycology (also VETMI 4040)
Spring. 2 or 3 credits; 3 credits with lec and sem. Prerequisites: BIOMI 2900 and 2910; for undergraduates, permission of instructor. Highly recommended: BIOG 3050. Offered alternate even years. D. Debbie.
For description, see VETMI 4040.]

BIOMI 4090 Principles of Virology (also VETMI/PLPA 4090)
Fall. 3 credits. Prerequisites: BIOMI 2900, 2910 or permission of instructor. Recommended: BIOBM 3300–3320, 4320. Letter grades only. G. R. Whittaker and S. G. Lazarowitz.
For description, see VETMI 4090.

BIOMI 4140 Prokaryotic Diversity
Spring. 3 credits. Prerequisites: BIOMI 2900 and 2910. Recommended: BIOBM 3300 or 3310 or 3330. Offered alternate odd-numbered years. S. H. Zinder.
Consideration of the evolutionary biology, physiology, ecology, genetics, and practical potential of important groups of prokaryotes. Topics include prokaryotic phylogeny, the evolution of diverse mechanisms of energy conservation, fixation of carbon and nitrogen, and adaptation to extreme environments.

[BIOMI 4160 Bacterial Physiology
Spring. 3 credits. Prerequisites: BIOMI 2900, 2910, and BIOBM 3300 or 3310, or equivalents. Offered alternate even years; next offered 2009–2010. J. P. Shapleigh.
Focuses on physiological and metabolic functions of bacteria. Consideration is given to chemical structure, regulation, growth, and energy metabolism. Special attention is given to those aspects of bacterial metabolism not normally studied in biochemistry courses.]

BIOMI 4180 Microbial Ecology
Spring. 3 credits. Prerequisites: BIOMI 2900 and 2910, or 3970 and permission of instructor, and BIOBM 3300 or 3310 and 3320. E. R. Angert.
Understanding the role of microorganisms in natural environments is one of the greatest challenges facing microbiologists. This course introduces current biochemical and macromolecule sequence-based methods to assess community diversity and microbial activity in a variety of ecosystems. Other topics discussed include bacterial growth and survival, population biology, and microbial interactions.

BIOMI 4200 Microbial Genomics
Spring. 2 credits. Prerequisites: BIOMI 2900, BIOGD 2810, BIOBM 3300, or equivalent. Offered alternate odd-numbered years. J. P. Shapleigh and J. D. Helmann.
Genomic information is revolutionizing biology. This course discusses the impact of genomic information on the study of microbial physiology, evolution, and biotechnology. Topics include both techniques (automated DNA sequencing, assembly, annotation, DNA chips) and applications (genome-wide analysis of transcription, functional genomics).

BIOMI 4310 Medical Parasitology (also VETMI 4310)
Fall. 2 credits. Prerequisites: zoology and biology courses. D. Bowman.
For description, see VETMI 4310.

BIOMI 4480 Symbiotic Associations: Evolution and Ecology (also PLPA 4480)
Spring. 3 credits. Prerequisites: two semesters of introductory biology (BIOG 1101–1102, BIOG 1105–1106, BIOG 1107–1108, or BIOG 1109–1110), and BIOMI 2900 or permission of instructor. Letter grades only. T. E. Pawlowska.
For description, see PLPA 4480.

[BIOMI 4823 Molecular Plant-Microbe Interactions (also BIOPL/PLPA 4823)
Spring. 1 credit. Prerequisites: BIOGD 2810, BIOBM 3300 or 3310 or 3330, and BIOPL 4830 or equivalents. S-U or letter grades. Offered alternate even years; next offered 2009–2010. S. C. Winans.
For description, see BIOPL 4823.]

BIOMI 4850 Bacterial Genetics (also BIOGD/BIOBM 4850)
Fall. 2 or 3 credits; optional 1 credit for registered students with permission of instructor to review literature. Prerequisite: BIOGD 2810. Recommended: BIOMI 2900 and BIOBM 3300 or 3310 and 3320 or 3330. J. E. Peters.
Students gain a detailed understanding of how bacteria maintain and pass on genetic information with a strong focus on the bacterium *Escherichia coli*. They discover the processes by which bacteria evolve through different mutations and the exchange of genetic information. The course explores how genes are regulated efficiently through negative and positive regulation and by global regulatory mechanisms. Upon completion of the course students should understand the tools used to manipulate bacterial genomes for the understanding of bacteria and other living organisms.

BIOMI 6080 Genomics of Bacterium-Host Interactions (also PLPA 6080)
Fall, second half of semester. 1 credit. Prerequisites: BIOMI 2900 or equivalent or permission of instructor. S-U or letter grades. Offered alternate even years. A. Collmer and S. Winans.
For description, see PLPA 6080.

BIOMI 6100 Introduction to Chemical and Environmental Toxicology (also TOX 6100)
Fall. 3 credits. Prerequisite: graduate standing in field or permission of instructor. Letter grades. A. Hay.
Introduction to the general principles of toxicology including the sources, mechanisms, and targets of toxic agents. Gives special attention to the interaction between toxic agents and biological systems at both the organismal and ecological level. The effects of both anthropogenic and natural toxins are examined with respect to genetic and developmental toxicity as well as carcinogenesis and specific organ toxicity.

BIOMI 6430 Veterinary Perspectives on Pathogen Control in Animal Manure (also VTMED/BEE 6430)
Spring, eight weeks. 2 credits. Prerequisite: third- and fourth-year veterinary students. Letter grades only. D. D. Bowman.
For description, see VTMED 6430.

BIOMI 6901 Prokaryotic Biology: Microbial Structure and Function
Fall, 4 weeks/8 lec. 1 credit. J. P. Shapleigh.
Discusses those macromolecules and assemblages of macromolecules that together define the structure of the prokaryotic cell. This includes external structures, such as cell wall, flagella, pili, and peptidoglycan and internal structures such as specialized vesicles and other large complexes.

BIOMI 6902 Prokaryotic Biology: Environmental Microbiology
Fall, 4 weeks/8 lec. 1 credit. E. L. Madsen.
Core course of concepts, methods, and current literature that reveals the multidisciplinary nature of environmental microbiology and its relationship to prokaryotic biology. Discusses the crucial roles that microorganisms play in catalyzing biogeochemical reactions throughout the biosphere.

BIOMI 6903 Prokaryotic Biology: Microbial Physiology/Diversity
Fall, 4 weeks/8 lec. 1 credit. S. H. Zinder.
Reviews the major energy-conserving modes of metabolism and their phylogenetic distributions among both bacteria and archaea. Topics include phylogenetic analysis, fermentation, respiration, photosynthesis, pathways of carbon and nitrogen fixation, and evolution of the three domains of life.

BIOMI 6904 Prokaryotic Biology: Microbial Genetics
Spring, 4 weeks/8 lec. 1 credit. J. D. Helmann.
Reviews the fundamental concepts of microbial genetics including mutations and their analysis, plasmids, conjugation, transformation, transduction, transposition, recombination, repair, and mutagenesis.

BIOMI 6905 Prokaryotic Biology: Microbial Pathogenesis
Spring, 4 weeks/8 lec. 1 credit. S. C. Winans.
Introduction to the fundamental concepts of bacterial pathogenesis including the normal flora, pathogen entry and colonization, the production and regulation of toxins, horizontal transfer of pathogenesis determinants, and the roles of both specific and nonspecific host defenses. Examples include bacterial pathogens of both animals and plants.

BIOMI 6990 Toxicology Journal Club Sec 01—Environmental Toxicology (TOX 6990)
Spring. 1 credit. Required for toxicology students until post A exam. A. G. Hay.

BIOMI 7250 Mechanisms of Microbial Pathogenesis (also VETMI 7250)
Spring. 3 credits. Prerequisites: for undergraduates, written permission of instructor; BIOMI 4040, 4090, or equivalent. Highly recommended: completion of two of the three courses. D. Debbie, M. Hesse, H. Marquis, J. Parker, M. Scidmore, and G. Whittaker.
For description, see VETMI 7250.

BIOMI 7910 Advanced Topics in Microbiology
Fall or spring. 1 credit; may be repeated for credit. Prerequisite: graduate standing in microbiology. S-U grades only. Sec 01 Bacterial Genetics, S. C. Winans; Sec 02 Environmental Microbiology, E. R. Angert.
Reading and presentation by graduate students of current literature in selected areas of modern microbiology.

BIOMI 7960 Current Topics in Microbiology
Fall and spring. 0.5 or 1 credit for each topic; may be repeated for credit. Primarily for graduate students in microbiology. Prerequisite: upper-level courses in microbiology. S-U grades only. Lec. Staff.
Lectures and seminars on special topics in microbiology.

BIOMI 7970 Scientific Communication Skills
Fall and spring. 1 credit each semester. Requirement for graduate students in graduate field of microbiology for first two semesters; third semester optional. S-U grades only. Staff.
The ability to communicate effectively is essential for success as a scientist. The primary goal of this course is to provide students with an opportunity to develop self-confidence and refine their formal oral presentation skills. Students are asked to present topical seminars that are critically evaluated by the instructor.

Feedback for improving the presentation and peer evaluations are emphasized.

BIOMI 7980 Graduate Research Seminar in Microbiology
Fall and spring. 1 credit each semester. Requirement for graduate students in graduate field of microbiology. S-U grades only. Staff.
All graduate students in the field of microbiology are required to attend and present a seminar concerning their research at least once each year.

BIOMI 7990 Microbiology Seminar
Fall and spring. Requirement for all graduate students in graduate field of microbiology. Open to all who are interested. Staff.

Related Courses in Other Departments

Advanced Food Microbiology (FDSC 6070)

Advanced Immunology Lectures (VETMI 7050)

Advanced Work in Bacteriology, Virology, or Immunology (VETMI 7070)

Phytobacteriology Research Updates (PLPA 6470)

Basic Immunology, Lectures (BIOG 3050, VETMI 3150)

Current Topics in Oomycete Biology (PLPA 6440)

Food Microbiology, Laboratory (FDSC 3950)

Food Microbiology, Lectures (FDSC 3940)

Immunology of Infectious Diseases (VETMI 7190)

Introduction to Scanning Electron Microscopy (BIOG 4010)

Fungi (PLPA 3090)

Light and Video Microscopy for Biologists (BIOG 4500)

Limnology: Ecology of Lakes, Lectures (BIOEE 4570)

Magical Mushrooms, Mischievous Molds (PLPA 2010)

Microbiology for Environmental Engineering (CEE 4510)

Plant Virology (PLPA 6450)

Principles of Biogeochemistry (BIOEE 6680)

NEUROBIOLOGY AND BEHAVIOR (BIONB)

BIONB 1110 Brain Mind and Behavior (also PSYCH/COGST 1110)
Spring. 3 credits. Prerequisite: none. Intended for freshmen and sophomores in humanities and social sciences; not open to juniors and seniors. Not recommended for psychology majors; biology majors may not use for credit toward major. Letter grades only. Planned M W F 9:05. E. Adkins-Regan and R. R. Hoy.
For description, see COGST 1110.

BIONB 1220 FWS: Special Topics in Neurobiology and Behavior

BIONB 1250 Biology Seminar
Fall and spring. 1 credit. Prerequisite: first-year standing or permission of instructor. S-U grades only. Staff.
A first-year seminar designed for students with Biology AP credit or a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

BIONB 2210 Neurobiology and Behavior I: Introduction to Behavior
Fall. 3, 4, or 5 credits; 4 credits with one disc per week; 5 credits with two disc per week and participation in Writing in the Majors program; 4- or 5-credit option required of students in neurobiology and behavior program of study. Limited to 15 students per 4-credit disc. Priority given to students studying neurobiology and behavior. Limited to 12 students in 5-credit option (students may not preregister for 5-credit option; interested students complete application form on first day of class). Not open to freshmen. Prerequisite: one year introductory biology for majors. May be taken independently of BIONB 2220. S-U or letter grades. Planned M W F 12:20; disc TBA. R. A. Raguso and staff.
General introduction to the field of animal behavior. Topics include evolution and behavior, behavioral ecology, sociobiology, chemical ecology, communication, orientation and navigation, and hormonal mechanisms of behavior.

BIONB 2213 Neurobiology and Behavior I: Introduction to Behavior
Summer, six-week session. 3 or 4 credits; 4 credits with one disc per week. Limited to 30 students. Prerequisite: one year introductory college biology. S-U or letter grades. Course fee: none. Planned M–F TBA. Staff.
General introduction to the field of animal behavior. Topics include evolution and behavior, behavioral ecology, sociobiology, chemical ecology, communication, orientation and navigation, and hormonal mechanisms of behavior.

BIONB 2220 Neurobiology and Behavior II: Introduction to Neurobiology
Spring. 3 or 4 credits; 4 credits with disc and written projects; 4-credit option required of students studying neurobiology and behavior. Limited to 15 students per disc; priority given to students studying neurobiology and behavior. Not open to freshmen. Prerequisites: one year introductory biology for majors and one year of chemistry. May be taken independently of BIONB 2210. S-U or letter grades. Planned M W F 12:20; disc TBA. J. R. Fetcho and staff.
General introduction to the field of cellular and integrative neurobiology. Topics include neural systems, neuroanatomy, developmental neurobiology, electrical properties of nerve cells, synaptic mechanisms, neurochemistry, motor systems, sensory systems, learning, and memory. Some discussion sections include dissections of preserved brains.

BIONB 3210 State of the Planet
Spring. 3 credits. Prerequisites: none. S-U grades only. Planned M W F 1:25–2:15. T. Eisner, M. L. Zeeman, and D. P. McCobb.
This interdisciplinary course is intended for any student with concern for the global criseswe collectively face. During this course you will be introduced to current data and engaged in analysis of those data, establish a global context for your specialized education, and be provided with a toolbox to bring awareness, analysis and action to your lives and careers beyond graduation.

BIONB 3220 Hormones and Behavior (also PSYCH 3220/7220)
Fall. 3 credits. Limited to 60 students. Prerequisites: junior or senior standing; any one of the following: PSYCH 2230 or BIONB 2210 or 2220 or one year introductory biology plus psychology course. Two lec plus sec in which students read and discuss original papers in the field, give oral presentation, and write term paper. Letter grades only. Graduate students, see PSYCH 7220. Planned M W F 11:15. E. Adkins-Regan.
For description, see PSYCH 3220.

[BIONB 3230 Methods in Animal Behavior
Fall. 4 credits. Limited to 24 students. Prerequisite: BIONB 2210. Letter grades only. Offered alternate years; next offered 2009–2010. Planned M W 1:25–4:25. Staff.
Hands-on lab/field course in methods for studying animal behavior. Topics include sound recording, videography radio-tracking, mapping, capture/marking methods, and behavioral statistics.]

BIONB 3240 Biopsychology Laboratory (also PSYCH 3240)
Fall. 4 credits. Limited to 20 students. Prerequisites: junior or senior standing; PSYCH 2230 or BIONB 2210 or 2220, and permission of instructor. Planned T R 1:25–4:25. Letter grades only. T. J. DeVoogd.
For description, see PSYCH 3240.

BIONB 3250 Insect Behavior (also ENTOM 3250)
Spring. 3 credits. Limited to 50 students. Prerequisite: ENTOM 2120 or BIONB 2210. Intended for juniors, seniors, and beginning graduate students. S-U or letter grades. Planned T R 10:10–11:25. Offered alternate years. L. S. Rayor.
For description, see ENTOM 3250.

[BIONB 3260 The Visual System
Spring. 4 credits. Limited to 25 students. Prerequisite: BIONB 2220 or BIOAP 3110 or permission of instructor. S-U or letter grades. Planned M W F 10:10; disc TBA. Offered alternate years; next offered 2009–2010. H. C. Howland.
The visual systems of vertebrates are discussed in breadth and depth as well as some aspects of invertebrate vision.]

BIONB 3280 Biopsychology of Learning and Memory (also PSYCH 3320/6320)
Spring. 3 credits. Limited to 65 students. Prerequisites: one year of biology and either a biopsychology course or BIONB 2220. S-U or letter grades. Graduate students, see PSYCH 6320. Planned M W F 11:15. T. J. DeVoogd.
For description, see PSYCH 3320.

BIONB 3290 Ecology of Animal Behavior (also BIOSM 3290)
Summer. 4 credits. Limited to 18 students. Prerequisite: one year introductory college biology. Recommended: ecology, psychology, or behavior course. S-U or

letter grades. Special two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. For more details and an application, contact SML office, G14 Stimson Hall. Daily lec, lab, and fieldwork for two weeks. SML faculty.
For description, see BIOSM 3290.

BIONB 3300 Introduction to Computational Neuroscience (also PSYCH/COGST/BME 3300)
Fall. 3 or 4 credits; 4 credits includes lab TBA providing additional computer simulation exercises. Limited to 25 students. Prerequisites: BIONB 2220 or permission of instructor. S-U or letter grades. Offered alternate years. Planned M W 2:55–4:10, lab TBA. C. Linster.
Covers the basic ideas and techniques involved in computational neuroscience. Surveys diverse topics, including neural dynamics of small networks of cells, neural coding, learning in neural networks and in brain structures, memory models of the hippocampus, sensory coding, and others.

BIONB 3310 Human Sociobiology
Spring. 3 credits. Limited to 100 students. Prerequisite: BIONB 2210 or PSYCH 2230 or permission of instructor. S-U or letter grades. Planned M W 2:55–4:10. P. Barclay.
Lecture-based course drawing on research in evolutionary biology and animal behavior to investigate various aspects of human social behavior. Findings are presented from areas such as evolutionary psychology, anthropology, human behavioral ecology, and evolutionary game theory. Topics may vary slightly from year to year, but include mating, cooperation (with kin and nonkin), conflict and aggression, parental behavior, costly signaling, and culture.

[BIONB 3400 Animal Orientation and Navigation
Spring. 2 credits. Pre- or corequisite: BIONB 2210 and BIONB 2220 or permission of instructor. S-U or letter grades. Planned: T R 9:05. Offered alternate years; next offered 2009–2010. K. Adler.
In-depth coverage of the topic, including sensory cues and receptors, physiological basis, ecological context, and evolutionary aspects, with emphasis on current research.]

BIONB 3690 Chemical Ecology (also BIOEE/ENTOM 3690)
Spring. 3 credits. Prerequisites: one semester of introductory biology for majors or nonmajors and one semester of introductory chemistry for majors or nonmajors or equivalents, or permission of instructor. S-U or letter grades. Planned M W F 11:15. A. Agrawal, G. Jander, A. Kessler, and J. Thaler.
For description, see BIOEE 3690.

[BIONB 3920 Drugs and the Brain
Fall. 4 credits. Limited to 90 students. Prerequisites: BIONB 2220 or equivalent course in neurobiology by permission of instructor. Recommended: knowledge of biochemistry. S-U or letter grades. Planned T R 10:10–11:25; disc TBA. Offered alternate years; next offered 2009–2010. R. M. Harris-Warrick.
Introduction to neuropharmacology, emphasis on neural mechanisms of psychoactive drugs, including cocaine, heroin, psychedelics, marijuana, alcohol, and drugs for psychiatric treatment.]

BIONB 3940 Circadian Rhythms (also BIOGD/ENTOM/PLPA 3940)
Fall. 2 or 3 credits (for optional lab sec see PLPA 3941). Prerequisite: 200-level biology course. S-U or letter grades. Planned T R 10:10–11; additional lab R 1:25–4:25 for 3-cr. option. K. Lee.
For description, see PLPA 3940.

[BIONB 3960 Introduction to Sensory Systems (also PSYCH 3960/6960)
Spring. 4 credits. Limited to 25 students. Prerequisites: introductory biology or biopsychology, plus second course in behavior, biopsychology, cognitive science, neuroscience, or perception; knowledge of elementary physics, chemistry, and behavior. S-U or letter grades. Planned T R 10:10–11:25. Offered alternate years; next offered 2009–2010. B. P. Halpern.
For description, see PSYCH 3960.]

[BIONB 4130 Molecules of Social Behavior and Emotion
Spring. 3 credits. Limited to 25 students. Prerequisite: permission of instructor. Letter grades only. Planned T R 10:10–11:25. Offered alternate years; next offered 2009–2010. D. P. McCobb.
Neurotransmitters, hormones, and receptors governing courtship, pair bonding, parental care, territoriality, cooperativity, stress responses, etc. Active learning format.]

BIONB 4200 Topics in Neurobiology and Behavior
Fall or spring. Variable credit; may be repeated for credit. Primarily for undergraduates. S-U or letter grades. Staff.
Courses on selected topics in neurobiology and behavior; can include lecture and seminar courses. See department office (W363 Mudd Hall) for offerings.

BIONB 4205 Topics in Neurobiology and Behavior: Darwinian Medicine Seminar
Summer, 6-week session. 3 credits. Pre- or corequisite: BIONB 2210. S-U or letter grades. Planned: M–F 3–4:15. J. Shellman Sherman.
We explore how and why a Darwinian approach to medicine can provide us with important insights and a more complete understanding of health and disease than that offered solely by a traditional approach to medicine. We consider evolutionary explanations for such phenomena as normal (healthy) and diseased body reactions in pregnancy, why we are sometimes vulnerable to obesity, why we are especially vulnerable to infectious diseases, why cultures respond differently to diseases, what evolutionary forces have molded our reproductive systems, why we exhibit allergies and cancer, mental diseases, and how and why we age. This course seeks to provide both pre-med and non-premed students with a Darwinian methodology for understanding health and disease. Premed students will undoubtedly eventually find it useful in their practices, and all will find the logic of the course practical in their everyday lives. A lecture is given on each topic, followed by interactive, student-led discussions where students are given an opportunity to research the topic of their choosing. Grades are based on class participation, short written summaries of each topical area, and a PowerPoint presentation of a self-selected topic.

BIONB 4210 Effects of Aging on Sensory and Perceptual Systems (also PSYCH 4310/6310)
Fall. 3 or 4 credits; 4-credit option involves term paper or creation of relevant web site. Limited to 35 students. Prerequisites: introductory course in biology or psychology, plus second course in perception, neuroscience, cognitive science, or biopsychology. Planned T R 10:10–11:25. B. P. Halpern.
For description, see PSYCH 4310.

[BIONB 4220 Modeling Behavioral Evolution
Fall. 4 credits. Limited to 25 students. Prerequisites: BIONB 2210, one year of calculus, course in probability or statistics, and permission of instructor; advanced undergraduates and graduate students. S-U or letter grades. Planned T R 2:55-4:10; computer lab TBA. Offered alternate years; next offered 2009–2010. H. K. Reeve.
Intensive lecture and computer lab course on modeling strategies in behavioral evolution. Population-genetic (including quantitative-genetic), static optimization, dynamic programming, game-theoretic methods.]

BIONB 4230 Cognitive Neuroscience (also PSYCH 4250/6250)
Fall. 4 credits. Limited to 20 students. Prerequisites: introductory biology; biopsychology or neurobiology (e.g., PSYCH 2230 or BIONB 2210); and introductory course in perception, cognition, or language (PSYCH 1200, 2090, 2140, or 2150 essential). S-U or letter grades. Graduate students, see PSYCH 6250. Planned M W F 9:05. One lab in sheep brain dissection. Offered alternate years. B. L. Finlay.
For description, see PSYCH 4250.

[BIONB 4240 Neuroethology (also PSYCH 4240)
Fall. 4 credits. Limited to 50 students. Prerequisites: BIONB 2210 and 2220, or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2009–2010. C. D. Hopkins.
A comparative approach to the study of neural circuits involved in animal behavior: echolocation, sound localization, communication and signal recognition, bird song, central pattern generators, command neurons, and other topics.]

[BIONB 4250 Molecular Neurophysiology
Fall. 3 credits. Limited to 20 students. Prerequisite: BIONB 2220 or permission of instructor. S-U or letter grades. Planned T R 2:55–4:10. Offered alternate years; next offered 2009–2010. D. P. McCobb.
Structure/function of ion channels responsible for electrical signals in, e.g., learning/memory, sensing heat and jalapeños, epilepsy, directional plant growth.]

[BIONB 4260 Animal Communication
Spring. 4 credits. Limited to 50 students. Prerequisite: BIONB 2210. Letter grades only. Planned T R 2:55–4:10; disc TBA. Offered alternate years; next offered 2009–2010. J. W. Bradbury and S. L. Vehrencamp.
How and why do animals communicate (topics include signal evolution, environmental effects on communication, cooperation vs. conflict signals, signal honesty, interspecific communication).]

BIONB 4270 Darwinian Medicine
Fall. 4 credits. Limited to 30 students. Prerequisites: BIONB 2210 and BIOEE 2610 or 2780, and permission of instructor. Letter grades only. Planned T R 2:30–4:25. Offered alternate years. P. W. Sherman.
Writing-intensive advanced course for upper-division students interested in Darwinian medicine. Lectures, discussions, and student presentations examine topics including adaptation, intra-genomic conflict, evolution of infectious disease, genetic diseases, virulence, sexuality, neuroendocrinology, stress, diet and disease, allergy, fever, morning sickness, lactose intolerance, depression and other mental illnesses, cancer, menopause, and senescence.

BIONB 4280 Clinical Neurobiology
Fall. 3 credits. Limited to 20 students. Prerequisites: two courses from BIONB 2220, BIOGD 2810, BIOBM 3300 or 3310; co-registration in one of the two is acceptable by permission of instructor. Open to advanced undergraduates. S-U or letter grades. Planned M W 2:30–4:25. Offered alternate years. R. Booker.
The goal of this course is to provide students with an appreciation of the current challenges facing researchers studying neurodiseases. The focus is on the etiology, epidemiology, cellular and molecular basis, and strategies for treating a number of neurodiseases, including but not limited to Alzheimer's disease, Parkinson's disease, neural ischemia, depression, ADHD, eating disorders, and AIDS-related dementia. The course provides a health context that enriches the student's learning experience in other advanced courses in the biological sciences. Guest speakers include faculty members from across the Ithaca campus and the Weill College of Medicine, Departments of Neurology and Neuroscience.

[BIONB 4290 Olfaction and Taste: Structure and Function (also PSYCH 4290)
Spring. 3 or 4 credits; 4-credit option requires term paper. Priority given to junior and senior psychology and biology majors and graduate students. Graduate students, see PSYCH 6290. Prerequisite: one 300-level course in biopsychology or equivalent. Planned T R 10:10–11:25. Offered alternate years; next offered 2009–2010. B. P. Halpern.
For description, see PSYCH 4290.]

BIONB 4300 Experimental Molecular Neurobiology
Spring. 4 credits. Limited to 12 students. Prerequisites: BIOBM 3300 or 3310. Recommended: BIOGD 2810. Letter grades only. Lab T (for times see www.nbb.cornell.edu/Faculty/deitcher/BioNB_430.html). Offered alternate years. D. L. Deitcher.
Experiments include PCR, cloning of DNA fragments, RNA purification, restriction digests, bacterial transformation, DNA sequencing, and protein interactions. Experiments emphasize how molecular techniques can be applied to studying neurobiological problems.

[BIONB 4310 Genes and Behavior
Spring. 3 credits. Limited to 50 students. Prerequisite: BIONB 2220. S-U or letter grades. Planned T R 2:55–4:10. Offered alternate years; next offered 2009–2010. J. R. Fetcho.
Genes influence how we behave. Explores current understanding of how genes influence the behavior of a variety of animals, including humans.]

BIONB 4320 Genetics and Evolution of Behavior
Spring. 3 credits. Limited to 20 students. Prerequisite: BIONB 2210. Letter grades only. Planned T R 2:55–4:10. Offered alternate years. K. Shaw.
The astounding diversity of animal behaviors provides an endless source of fascination. This multidisciplinary course examines our current understanding of the evolution of such behavior, focusing on how and why behaviors evolve. Course material assists an integration of molecular genetic, population genetic and phylogenetic perspectives, emphasizing the animal diversity found in natural systems. Topics include the evolution of feeding, sexual, parental, social and predator-prey behaviors. Part lecture, part discussion with active-learning component.

BIONB 4440 Neural Computation (also PSYCH 4440)
Spring. 3 credits. Limited to 10 students. Prerequisites: BIONB 2220 or permission of instructor. S-U or letter grades. Planned T R 2:30–3:20, lab T R 3:35–4:25. Offered alternate years. T. A. Cleland.
For description, see PSYCH 4440.

[BIONB 4460/4461 Plant Behavior—Induced Plant Responses to Biotic Stresses]

BIONB 4700 Biophysical Methods (also AEP/VETMM 4700)
Fall. 3 credits. Prerequisites: solid knowledge of basic physics and mathematics through sophomore level. Recommended: knowledge of cellular biology. Letter grades only. Planned M W 2:45–4:15. M. Lindau.
For description, see AEP 4700.

BIONB 4910 Principles of Neurophysiology (also BME 4910)
Spring. 4 credits. Limited to 20 students. Prerequisite: BIONB 2220 or written permission of instructor. S-U or letter grades for students outside the Neurobiology and Behavior concentration and graduate students, by permission of instructor. Planned M W 10:10; lab planned M or T 12:20–4:25. B. R. Johnson.
Laboratory-oriented course designed to teach the theory and techniques of modern cellular neurophysiology including computer acquisition and analysis of laboratory results. Lecture time is used to introduce laboratory exercises and discuss results, to supplement laboratory topics, and to discuss primary research papers. Extracellular and intracellular recording and voltage clamp techniques explore motor neuron and sensory receptor firing properties, and examine the cellular basis for resting and action potentials and synaptic transmission. Invertebrate preparations are used as model systems. See instruct1.cit.cornell.edu/courses/bionb491/index.html.

BIONB 4920 Sensory Function (also PSYCH 4920/6920)
Spring. 4 credits. Limited to 25 students. Prerequisite: 3000-level course in biopsychology, or BIONB 2220, or BIOAP 3110, or equivalent; knowledge of elementary physics, chemistry, and behavior. S-U or letter grades. Graduate students, see PSYCH 6920. Planned M W F 10:10. Offered alternate years. H. C. Howland and B. P. Halpern.
For description, see PSYCH 4920.

[BIONB 4930 Developmental Neurobiology
Fall. 3 credits. Limited to 20 students. Prerequisite: BIONB 2220 or permission of instructor. S-U or letter grades by permission of instructor. Planned M W 2:55–4:10. Offered alternate years; next offered 2009–2010. R. Booker.
Focuses on both the morphological and molecular basis of neurodevelopment. Assigned readings are taken from original journal and review articles.]

[BIONB 4940 Brain Evolution and Behavior
Spring. 3 credits. Limited to 50 students. Intended for juniors, seniors, and graduate students. Prerequisite: BIONB 2220 or equivalent. S-U or letter grades. Offered alternate years; next offered 2009–2010. A. H. Bass.
Organization and evolution of neuroanatomical pathways as substrates for species-typical vertebrate behaviors.]

BIONB 4950 Molecular and Genetic Approaches to Neuroscience
Fall. 3 credits. Limited to 25 students. Prerequisites: junior, senior, or graduate standing; BIONB 2220 and BIOBM 3300 or 3320. Letter grades only. Planned T R 2:55–4:10. Offered alternate years. D. L. Deitcher.
Focuses on how different molecular and genetic approaches have led to major advances in neuroscience. Lectures, student presentations, and discussions examine original research articles. Topics include ligand-gated channels, potassium channels, seven membrane spanning receptors, development of the neuromuscular junction, neurotransmitter release, second messengers, learning and memory, and neurodiseases.

[BIONB 4960 Bioacoustic Signals in Animals and Man
Fall. 3 credits. Limited to 12 students. Prerequisites: junior, senior, or graduate standing; one year introductory biology, PHYS 1101–1102 or 2207–2208, and permission of instructor. S-U or letter grades. Planned M W 9:05; lab TBA. Offered alternate years; next offered 2009–2010. C. W. Clark and R. R. Hoy.
Teaches students about animal acoustic signaling by introducing them to various animal acoustic systems.]

BIONB 4980 Teaching Experience
Fall or spring. 1–4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, upon petition (one time only) to their class dean, carry fewer than 12 other credits and remain in good standing. This would affect Dean's List eligibility but not eligibility for graduating with distinction. S-U or letter grades by permission of the instructor. Staff.
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and assisting in biology courses. This experience may include supervised participation in a discussion group, assisting in a biology laboratory, assisting in field biology, or tutoring.

BIONB 5310 Borges and I: A Quest for Self-Knowledge
Spring. 4 credits. Limited to 15 students. Prerequisite: PSYCH 2140. Planned M 2–4:25. S. Edelman.
For description, see PSYCH 5310.

BIONB 7200 Seminar in Advanced Topics in Neurobiology and Behavior
Fall or spring. Variable credit; may be repeated for credit. Prerequisite: graduate standing or permission of instructor. S-U or letter grades. Staff and students.
Designed to provide several study groups each semester on specialized topics. A group may meet for whatever period is judged adequate to enable coverage of the selected topics. Ordinarily, topics are selected and circulated during the preceding semester. Discussion of current literature is encouraged. Suggestions for topics should be submitted by faculty or students to the chair of the Department of Neurobiology and Behavior.

BIONB 7201 Research Design in the Study of Animal Social Behavior
Fall and spring. 1 credit; may be repeated for credit. Graduate students only. S-U grades only.
A weekly journal club–style discussion. Graduate students may be expected to present a summary of their research or a summary of research in the literature related to their thesis once per year.

BIONB 7202 Current Topics in Neuroethology
Fall and spring. 1 credit; may be repeated for credit. Graduate students only. S-U grades only.
A weekly journal club–style discussion. Graduate students may be expected to present a summary of their research or a summary of research in the literature related to their thesis once per year.

BIONB 7203 Research Design in Cellular and Molecular Neurobiology
Fall and spring. 1 credit; may be repeated for credit. Graduate students only. S-U grades only.
A weekly journal club–style discussion. Graduate students may be expected to present a summary of their research or a summary of research in the literature related to their thesis once per year.

BIONB 7210 Introductory Graduate Survey in Neurobiology and Behavior
Fall. 2 credits. Requirement for graduate students majoring in neurobiology and behavior. Concurrent registration in BIONB 2210 and 2220 not required. S-U grades only. Planned W 4–6. J. R. Fetcho and staff.
Lectures, readings, and discussion introduce first-year graduate students to the research activities of the faculty in the graduate field of neurobiology and behavior. Class meets weekly for two hours. Students also prepare a research proposal on a potential topic for their thesis research (in the format of an NSF or NIH grant). This proposal is prepared in consultation with one or more relevant faculty members.

Related Courses in Other Departments

Evolutionary Perspectives on Behavior (PSYCH 6350)

Biopsychology of Normal and Abnormal Behavior (PSYCH/NS 3610)

Developmental Biopsychology (PSYCH 4220)

Evolution of Human Behavior (PSYCH 3260)

Topics in Biological Anthropology (ANTHR 4390)

Primate Behavior and Ecology (ANTHR 3390)

Teaching Experience (BIOG 4980)

The Brain and Sleep (PSYCH 4400/6400)

Independent Undergraduate Research in Biology (BIOG 4990)

OTS Undergraduate Semester Abroad Programs

Shoals Marine Laboratory Program

Spider Biology: Life on a Silken Thread (ENTOM 2150)

Navigation, Memory, and Context: What Does the Hippocampus Do? (PSYCH 4230/6230)

PLANT BIOLOGY (BIOPL)

BIOPL 1120 Issues in Social Biology: from Diet to Diseases, DNA to Deforestation
Spring. 3 credits. S-U or letter grades. P. J. Davies.
An analysis of current issues of biological relevance and the biological science behind these issues. Topics will include issues such as food and nutrition, antioxidants, organic produce, disease prevention, athletic enhancers, genetic testing, cancer, stem cells and animal cloning, genetically modified crops, bacteria and antibiotics, viruses, risk, statistics and epidemiology, photosynthesis and global warming, extinction and overpopulation, invasive species, resource over-utilization. The topics will vary according to current issues.

BIOPL 1250 Biology Seminar
Fall and spring. 1 credit. Prerequisite: first-year standing or permission of instructor. S-U grades only. Staff.
A first-year seminar designed for students with Biology AP credit or a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

BIOPL 2210 Natural Remedies in Ethnohealth
Fall. 2 credits. Prerequisites: course work in biology and sociology and health or related area, or permission of instructor. E. Rodriguez.
This course is an introduction to two aspects of ethnomedicine/ethnohealth: (1) the study of biology of health disparities like diabetes, cancer, and infectious diseases in Latinos/as, African Americans and American Indians in the United States, (2) and the botany, culture, and medical anthropology of plants and other natural remedies used by ancient cultures in the Americas and also currently used throughout the United States and the Americas.

BIOPL 2400 Green World/Blue Planet
Fall. 3 credits. S-U or letter grades. Lec. T. Silva.
Focuses on helping individuals understand how scientific information relates to the issues they face as citizens, in management decision making, and in public policy. To what extent should genetic engineering of crop plants be permitted? Should we place limits on fossil fuel consumption as a means of limiting global warming and global climate change? Must human endeavors be restricted in certain areas to maintain diversity? The format of this course is interactive, with lectures and discussions about how we as a society deal with controversial issues.

BIOPL 2410 Introductory Botany
Fall. 3 credits. Lec, lab. K. J. Niklas.
Introductory botany for those interested in the plant sciences. Emphasizes structure, reproduction, and classification of angiosperms and the history of life on earth. Laboratory emphasizes development of skills in handling plant materials, including identification. First and second weeks of laboratory are field trips, starting with the first day of classes. *Those who register for an evening laboratory are still required to attend the afternoon field trips.*

BIOPL 2420 Plant Function and Growth Lectures
Spring. 3 credits. Primarily for undergraduates in agricultural sciences but also for any biological sciences students wanting to know about plant function; suitable as second-level course for nonmajors to satisfy biology distribution requirement. Prerequisites: one year introductory biology and/or BIOPL 2410. Corequisite for plant science undergraduates (and highly recommended for other science majors): BIOPL 2440. Recommended: one year introductory chemistry. May not be taken for credit after BIOPL 3420 except by written permission of instructor. S-U or letter grades. Evening prelims. P. J. Davies.
How plants function and grow. Examples deal with crop plants or higher plants where possible, though not exclusively. Topics include cell structure and function; plant metabolism, including photosynthesis; light relations in crops; plant-water relations; water uptake, transport, and transpiration; irrigation of crops; sugar transport; mineral nutrition; growth and development—hormones, responses to light, flowering, fruiting, dormancy, and abscission; stress; tissue culture; and genetic engineering of plants.

BIOPL 2421 Plant Function and Growth, Laboratory
Spring. 2 credits. Limited to 14 students per sec. Corequisite: BIOPL 2420. May not be taken for credit after BIOPL 3440. Disc and lab; students must take lab and disc on same day. T. Silva.
Experiments exemplify concepts covered in BIOPL 2420 and offer experience in a variety of biological and biochemical techniques, from the cellular to whole plant level.

BIOPL 2430 Taxonomy of Cultivated Plants (also HORT 2430)
Fall. 4 credits. Prerequisite: one year introductory biology or written permission of instructor. May not be taken for credit after BIOPL 2480. Lec, lab. Offered alternate years. M. A. Luckow.

Study of ferns and seed plants, their relationships, and their classification into families and genera, emphasizing cultivated plants. Particular emphasis is placed on gaining proficiency in identifying and distinguishing families and in preparing and using analytic keys. Attention is also given to the economic importance of taxa, to the basic taxonomic literature, and to the elements of nomenclature.

BIOPL 2450 Plant Biology
Summer, six-week session. 3 credits. Limited to 24 students. Lec, lab. T. Silva.
Introductory botany, including plant identification. Emphasizes structure, reproduction, and classification of flowering plants. Much of the laboratory work is conducted outdoors taking advantage of several outstanding natural areas available for study. Those who lack college-level biology are expected to work closely with the instructor on supplemental instructional materials.

[BIOPL 2470 Ethnobiology]

[BIOPL 2480 Taxonomy of Vascular Plants
Spring. 4 credits. Prerequisite: one year introductory biology. May not be taken for credit after BIOPL 2430. S-U or letter grades. Lec, lab. Offered alternate years; next offered 2009–2010. J. I. Davis.
Introduction to the classification of vascular plants, with attention to the goals of taxonomy, the processes of plant evolution, and the means of analyzing evolutionary relationships among plants. The laboratory presents an overview of vascular plant diversity, with particular attention to the flowering plants.]

BIOPL 3420 Plant Physiology, Lectures
Spring. 3 credits. Prerequisites: one year introductory biology. Corequisite: BIOPL 3440 or written permission of instructor. May not be taken for credit after BIOPL 2420 unless written permission obtained from instructor. Lec. T. G. Owens.
Integrated and interdisciplinary study of the processes that contribute to the growth, competition, and reproduction of plants. Topics include, but are not limited to, plant-water relations, membrane properties and processes, photosynthesis, plant respiration, mineral and organic nutrition, stress physiology, control of growth and development, and responses to the environment. Emphasis is on the relationship between structure and function from the molecular to the whole-plant level.

BIOPL 3421 Plant Physiology, Laboratory
Spring. 2 credits. Corequisite: BIOPL 3420. May not be taken for credit after BIOPL 2440. Similar to BIOPL 2440 but at more advanced level. Lab, disc. T. Silva.
Experiments exemplify concepts covered in BIOPL 3420 and offer experience in a variety of biological and biochemical techniques, from the cellular to whole plant level, with emphasis on experimental design.

BIOPL 3430 Molecular Biology and Genetic Engineering of Plants
Spring. 2 credits. Prerequisite: one year general biology or permission of instructor. S-U or letter grades. Lec. M. E. Nasrallah.
Introduction to current studies involving recombinant DNA technology and its application to the improvement of plants. Emphasizes genetic transformation methodology, gene expression systems, and strategies for increasing productivity. The course is directed toward undergraduates who wish to become familiar with the theory and practice of plant biotechnology.

BIOPL 3431 Laboratory in Molecular Biology and Genetic Engineering of Plants
Spring. 2 credits. Limited to 24 students. Prerequisite: BIOPL 3430 or permission of instructor. Recommended: concurrent enrollment in BIOPL 3430. S-U or letter grades. Lab. M. E. Nasrallah.
Companion to BIOPL 3430 with laboratory activities that focus on the practice of plant biotechnology. Students transfer genes to plants by a variety of methods and analyze their expression in the host genome by use of reporter gene assays and by the preparation and analysis of nucleic acids.

[BIOPL 3450 Plant Anatomy
Fall. 4 credits. Limited to 15 students. Prerequisite: one year introductory biology or a semester of botany. Lec, lab. Next offered 2009–2010. A. Gandolfo.
Descriptive course with equal emphasis on development and mature structure. Lecture, laboratory, and reading are integrated in a study guide. The laboratory offers the opportunity to develop the practical skills required to make anatomical diagnoses and to write anatomical descriptions.]

[BIOPL 3480 The Healing Forest
Spring. 2 credits. Prerequisites: introductory biology or plant biology or permission of instructor. Lec/disc. Offered alternate years. Staff.]

BIOPL 3590 Biology of Grasses
Spring 2 credits. Prerequisite: one year introductory biology or course in plant systematics or permission of instructor. S-U or letter grades. Lec. Lab. Offered alternate years. J. I. Davis.
Systematics and related aspects of the biology of the graminoid plant families (grasses, sedges, and rushes), with the principal emphasis on grasses. Major topics include phylogenetics, taxonomy, physiology, reproductive biology, speciation, and biogeography. The roles of graminoid plants in natural and human-disturbed environments are discussed, as are the origins of cultivated species.

BIOPL 3800 Strategies and Methods in Drug Discovery
Spring. 2 credits. Prerequisite: one year introductory biology and organic chemistry course or permission of instructor. S-U or letter grades. M. A. Aregullin.
Covers strategies and methodologies in chemotaxonomy, chemical ecology, and ethnobotany, as they are used in chemical prospecting for new pharmaceuticals. Discusses the biosynthesis and distribution of plant secondary metabolites, the use of techniques in isolation and structure elucidation of natural products, and biological assays in the discovery of chemicals with pharmacological activity.

[BIOPL 4010 Introduction to Scanning Electron Microscopy]

[BIOPL 4030 Transmission Electron Microscopy for Biologists]

BIOPL 4040 Crop Evolution, Domestication and Diversity (also PLBR/IARD 4040)
Fall. 2 credits. Prerequisites: BIOGD 2810 or PLBR 2250 or permission of instructor. S-U or letter grades. Lec. S. Kresovich.
For description, see PLBR 4040.

BIOPL 4220 Plant Development
Fall. 2 credits. Lec. Prerequisites: course work in molecular biology (e.g., BIOBM 3300, 3310/3320, or 3330), and genetics (e.g., BIOGD 2810), or permission of instructor. S-U or letter grades. J. Hua.
Introduction to plant development, studying the mechanisms of morphogenesis and cell fate determination at the organismal, cellular, and molecular levels.

BIOPL 4400 Phylogenetic Systematics (also ENTOM 4400)
Spring. 4 credits. Limited to 24 students. Prerequisite: introductory biology or permission of instructor. Lec, lab. Offered alternate years. K. C. Nixon.
Basic and advanced theory and methods of phylogenetic analysis. Introduces students to cladistic analysis using parsimony and gain experience with computer-aided analysis of taxonomic data, including both morphological and molecular data sources. Topics include applications of phylogenetic methods to biogeography and evolutionary studies.

[BIOPL 4420 Current Topics in Ethnobiology
Fall. 2 credits. Limited to 12 students. Prerequisite: permission of instructor. S-U or letter grades. Lec/disc. Offered alternate years. Staff.]

BIOPL 4430 Topics and Research Methods in Systematics
Fall or spring. 1–2 credits; 1 credit per sec. Prerequisite: written permission of instructor. S-U or letter grades. K. C. Nixon.
Series of 1-credit modules on specialized topics in systematics. Topics and instructors vary each semester. May not be taught every semester. Topics and instructors are listed in the division's catalog supplement issued at the beginning of the semester.

BIOPL 4440 Plant Cell Biology
Fall. 4 credits. Limited to 24 students. Prerequisites: one year introductory biology or permission of instructor. Lec, lab. R. O. Wayne.
Uses evidence from microscopy, physiology, biochemistry, and molecular biology to try to unravel the mystery of the living cell. Studies the dynamics of protoplasm, membranes, and the various organelles. The mechanisms of cell growth and division, the relationship of the cytoskeleton to cell shape and motility, the interaction of the cell with its environment, and the processes that give rise to multicellular differentiated plants are investigated.

[BIOPL 4470 Molecular Systematics
Fall. 3 credits. Prerequisites: BIOEE 2780 or BIOGD 2810 or BIOBM 3300, or BIOBM 3320, or written permission of instructor. Lec. Offered alternate years; next offered 2009–2010. J. J. Doyle.
Theory and practice of using molecular evidence, particularly DNA sequence data, for addressing diverse systematic and evolutionary questions. Emphasis is on phylogeny reconstruction, particularly in eukaryotic systems. The organization and evolution of nuclear and organellar genomes is described from the standpoint of their suitability for systematic and evolutionary studies.]

BIOPL 4480 Plant Evolution and the Fossil Record
Spring. 3 credits. Prerequisite: BIOPL 2410 or equivalent, or permission of instructor. Lec, lab. Offered alternate years. K. J. Niklas and W. L. Crepet.
Introduction to evolution, surveying major changes in plants from the origin of life to the present. Emphasizes plant form and function, adaptations to particular ecologic settings, and evolutionary theory as it relates to plants.

[BIOPL 4490 Green Signals and Triggers—The Plant Hormones (also HORT 4490)
Spring. 2 credits. Prerequisite: one year introductory biology and plant physiology (BIOPL 2420 or 3420) or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2009–2010. P. J. Davies.
Study of plant hormones and how they regulate plant growth and development. Topics include the discovery, role in growth and development, mode of action, and practical uses of the plant hormones auxin, gibberellins, cytokinins, abscisic acid, ethylene, and brassinosteroids.]

BIOPL 4500 Light and Video Microscopy for Biologists
Fall. 3 credits. Limited to 12 students. Prerequisites: one year introductory biology and permission of instructor. Lec, lab. R. O. Wayne.
Students learn the relationship between reality and the image using philosophy, mathematics, and physical theory. Next they apply these tools theoretically and in practice to understand and become experts at image formation and analysis using brightfield, darkfield, phase-contract, fluorescence, polarization, interference, differential interference, and modulation contrast microscopes. They build upon our knowledge and experience to understand how analog image processors and digital image processors can influence, enhance, and analyze the images gathered by the microscope. Last they learn about many other kinds of microscopes, including confocal, near field, x-ray, acoustic, nuclear magnetic resonance, infrared, centrifuge, atomic force, and scanning tunneling microscopes.

[BIOPL 4520 Systematics of Tropical Plants
Fall. 3 credits. Prerequisite: BIOPL 2430 or 2480. Letter grades only. Lec, lab. Offered every three years. K. C. Nixon.
The families of plants encountered solely or chiefly in tropical regions are considered in a phylogenetic context in lectures, discussions, and laboratory, with the aim of providing basic points of recognition for, and an understanding of, diversity and relationships in these families.]

[BIOPL 4521 Systematics of Tropical Plants: Field Laboratory
Spring. 1 credit. Limited to 15 students. Prerequisite: BIOPL 4520 or permission of instructor. Letter grades only. For more details and application, contact L. H. Bailey Hortorium, 467 Mann Library. Offered every three years. K. C. Nixon.
Intensive orientation to families of tropical flowering plants represented in forests of the American Tropics. Emphasis is on field identification combined with laboratory analysis of available materials in a "whole-biology" context. Two-week field trip over winter break.]

[BIOPL 4530 Principles and Practice of Historical Biogeography (also ENTOM 4530)
Fall. 3 credits. Prerequisite: systematics course or permission of instructors. S-U or letter grades. Lec, lab. Offered alternate years; next offered 2009–2010. J. K. Liebherr and M. A. Luckow.
For description, see ENTOM 4530.]

BIOPL 4620 Plant Biochemistry
Spring. 3 credits. Prerequisites: BIOPL 2420 or 3420 or equivalent and BIOBM 3300 or 3310 or equivalent or permission of instructor. Letter grades only. Lec. J. Rose and K. Van Wijk.
Focuses on biochemistry of plant specific processes, with the aim to obtain an integrative overview of plant biochemistry. Examples include processes such as cell wall biochemistry, pigment biosynthesis and degradation, secondary metabolism, senescence, defense mechanisms, amino acid biosynthesis, and small molecule transport. Genomics-based experimental tools such as proteomics and metabolomics are discussed.

BIOPL 4821–4822 Molecular Plant-Pathogen Interactions I and II (also PLPA 4821)
Spring. 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOB 3310. S-U or letter grades. A. Collmer and B. G. Turgeon, odd years; S. G. Lazarowitz and G. Martin, even years.
For description, see PLPA 4821 and 4822.

[BIOPL 4823 Molecular Plant-Microbe Interactions (also BIOMI 4640, PLPA 4822)
Spring. 1 credit. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U or letter grades. 12 lec. Offered alternate years; next offered 2009–2010. S. C. Winans.
Focuses on the interactions of *Agrobacteria* and *Rhizobia* with plants. Topics on *Agrobacterium*-plant interactions include plant-microbe recognition mechanisms, T-DNA transfer process, oncogenesis, and use of *Agrobacterium* to produce transgenic plants. Topics on *Rhizobium*-plant interactions include regulation of nitrogenase activity and expression, organization and function of the *sym* plasmid, nodule development, and plant genetics involved in plant-microbe interaction.]

BIOPL 4824 Plant Gene Evolution and Phylogeny
Spring. 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. Offered alternate years. J. J. Doyle.
Practical applications of molecular systematics/evolution for plant molecular biologists and other non-systematists. The course focuses on two basic issues: methods and principles for inferring relationships among genes and the use of data to hypothesize relationships among plants. Evolutionary patterns and processes of genes and gene families are discussed, as well as rates of sequence evolution, paralogy and orthology, the effects of recombination and concerted evolution of gene phylogenies, and the implications of using gene or allele phylogenies to infer organismal evolutionary patterns.

BIOPL 4825 Molecular Biology of Plant Organelles (also BIOGD 4825)
Spring. 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U grades by permission of instructor. M. R. Hanson and D. B. Stern.
Plants contain three different genomes—in the nucleus, chloroplasts, and mitochondria. This course examines the organization, expression, and evolution of plant organelle genomes. Special topics include RNA editing and stability, effects of organelle mutations on plant reproduction and photosynthesis, and chloroplast transformation for expression of useful foreign proteins.

BIOPL 4826 Plant Biotechnology (also PLBR 4826)
Spring. 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U or letter grades. E. D. Earle.
Deals with production and uses of transgenic plants for agricultural and industrial purposes. Topics include procedures for gene introduction and control of gene expression, as well as strategies for obtaining transgenic plants that are resistant to insects, diseases, and herbicides, produce useful products, or have improved nutritional and food processing characteristics. Regulatory and social issues relating to plant biotechnology are discussed.

[BIOPL 4827 Plant Cell Walls: Structure to Proteome
Spring. 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U or letter grades. 12 lec. Offered alternate years; next offered 2009–2010. J. Rose.
Examines the structure and function of plant cell walls, exploring their dynamic nature and fundamental contribution to numerous aspects of plant growth and development. Topics include wall biosynthesis; wall structure and composition; regulation of cell expansion and differentiation; defense against pathogens and signaling; the apoplast as a metabolically active subcellular compartment; and analytical techniques: from biochemistry to proteomics.]

BIOPL 4828 Plant Imaging
Spring. 1 credit. 4 weeks. Limited to 12 students. Priority given to graduate students. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U or letter grades. Offered alternate years. R. Turgeon.
At some point, most research projects involve structural analysis. This may necessitate hand sectioning, in situ hybridization, electron microscopy, confocal imaging, or any of a host of other possibilities. The key to success is having a proper foundation so that the correct choice of procedures can be made. This course provides an overview of the theory of practical light and electron microscopy focusing on plant tissue preparation, hand and microtome sectioning, staining, optical techniques, histochemistry, and the localization of macromolecules. Students will gain an appreciation of the potentials and limitations of available methods and learn how these methods can be combined to answer specific research questions. The course will consist of six lectures and four two-hour labs, plus a short project.

[BIOPL 4829 Light Signal Transduction in Plants
Spring. 1 credit. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U or letter grades. 12 lec. Offered alternate years; next offered 2009–2010. T. Brutnell.
In addition to providing plants with energy for photosynthesis, light plays an essential role in the development of higher plants. Light quality and intensity is carefully monitored by the plant to avoid neighboring vegetation, set the circadian clock, and adjust photosynthesis rates. This course focuses on recent studies that have illuminated the molecular basis of light signal transduction networks in higher plants. Readings are assigned from current literature with an emphasis on those that use genomics tools such as microarray analysis to address fundamental questions in red/far-red and blue light signal transduction.]

BIOPL 4831 Concepts and Techniques in Plant Molecular Biology (also PLPA/PLBR 4831)
Fall. 2 credits. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. Lec. S-U or letter grades. S. R. McCouch, J. Giovannoni, and J. Rose.
Introductory module that provides a broad overview of molecular biology concepts relevant to the plant sciences. Serves as a prerequisite to other modules in the BIOPL 4830 (fall) and BIOPL 4820 (spring) series. The course is divided into three sections: (1) Gene discovery: covers genetic, molecular, and genomics approaches to the isolation of plant genes; (2) Gene characterization: covers DNA sequence analysis, assessment of gene expression, functional genomics approaches, and production of transgenic plants; (3) Analysis and characterization of proteins and metabolites: includes proteomics approaches to the analysis of plant proteins, protein-protein interactions, and metabolic profiling through emerging metabolomic techniques. This course consists of two lectures and one day of discussion per week. Course material is coordinated with BIOPL 6410 (lab). Emphasis is on understanding techniques and approaches appropriate for different experiments and objectives.

BIOPL 4832 Proteomics in Plant Biology
Fall. 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U or letter grades. K. van Wijk.
Introduction to proteomics and mass spectrometry and its application in plant biology. Includes discussion of protein separation, protein tagging and visualization techniques; principles of biological mass spectrometry and interpretation of spectra; bioinformatics tools in proteomics; comparative proteomics; phosphorylation mapping. Discusses limitations and possibilities of proteomics on plants for which little sequence information is available and experimental papers involving plant proteomics.

BIOPL 4833 Plant Genome Organization and Function (also PLBR 4833)
Fall. 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U or letter grades. Offered alternate years. S. D. Tanksley.
Covers the structure and variation of plant nuclear genomes, including changes in genome size, centromere/telomere structure, DNA packaging, transposable elements, genetic and physical mapping, positional gene cloning, genomic sequencing and comparative genomics.

BIOPL 4834 Molecular Aspects of Plant Development I (also BIOBM 4834)
Fall 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. J. B. Nasrallah.
Focuses on the molecular genetics of plant development with an emphasis on plant reproductive biology. Current approaches to the elucidation of the molecular signals and pathways that lead to the establishment of the differentiated state of floral cells and organs are discussed. Topics include cell-cell signalling in the establishment of pattern and functional differentiation of specialized cell types, and the control of developmental pathways by endogenous and external cues. It is a companion to BIOPL 4823 (Molecular Plant-Microbe Interactions).]

[BIOPL 4835 Molecular Breeding (also PLBR 4835)
Fall. 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U or letter grades. Offered alternate years; next offered 2009–2010. S. D. Tanksley.
Application of DNA markers to the identification, manipulation, and isolation of genes important to plant and animal productivity using molecular genetic techniques. Students learn how to design and execute experiments to identify quantitative trait loci (QTLs), as well as how to apply molecular markers to plant and animal breeding programs.]

BIOPL 4836 Plant Senescence (also HORT 6252)
Fall. 1 credit. 12 lec. Prerequisites: BIOGD 2810 and BIOBM 3300 or 3320, or equivalents. Recommended: BIOBM 3310. S-U or letter grades. (12 lec). S. Gan.
Introduces molecular, genetics, and genomics approaches in plant senescence and postharvest research. Topics include gene expression, regulation, and function associated with physiological and biochemical changes in senescing, maturing, and/or ripening plants or parts. Genetic manipulation of senescence/ripening processes are also discussed.

BIOPL 4980 Teaching Experience
Fall or spring. 1–4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, upon petition (one time only) to their class dean, carry fewer than 12 other credits and remain in good standing. This would affect Dean's List eligibility but not eligibility for graduating with distinction. S–U or letter grades by permission of the instructor. Staff.
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and assisting in biology courses. This experience may include supervised participation in a discussion group, assisting in a biology laboratory, assisting in field biology, or tutoring.

BIOPL 6410 Laboratory in Plant Molecular Biology (also BIOBM 6410)
Fall. 4 credits. Prerequisites: BIOGD 2810 or equivalent, BIOBM 3300 or 3310 or equivalent, and permission of instructor. S-U grades by permission of instructor. Lab. M. R. Hanson, H. Wang, T. Brutnell, G. Jander, J. Hua, M. Scanlon, and K. van Wijk.
Includes selected experiments on gene expression, biolistic transformation, confocal microscopy, laser capture microdissection, microarray analysis, genetic mapping and mutant analysis, transposon tagging, proteomics, and metabolite analysis.

BIOPL 6420 Plant Mineral Nutrition (also CSS 6420)
Spring. 3 credits. Prerequisite: BIOPL 3420 or equivalent. Lec. Offered alternate years. O. K. Vatamaniuk, L. V. Kochian, and R. M. Welch.
For description, see CSS 6420.

BIOPL 6470 Systematic Biology Journal Club
Fall or spring. 1 credit; may be repeated for credit. Intended for graduate students and advanced undergraduates in systematic biology. S-U grades only. Disc TBA. Bailey Hortorium staff.
Discussions led by staff, visitors, and students on topics of current importance to systematic biology.

BIOPL 6490 Solute Transport in Plants (also BEE 6490)
Fall. 3 credits. Letter grades only. Lec. Offered alternate years. R. M. Spanswick.
For description, see BEE 6490.

[BIOPL 6510 Water Transport in Plants (also BEE 6470)
Fall. 2 credits. Letter grades only. Lec. Offered alternate years; next offered 2009–2010. R. M. Spanswick.
For description, see BEE 6470.]

[BIOPL 6540 Botanical Nomenclature
Fall. 3 credits. Prerequisite: written permission of instructor. S-U or letter grades. Lec and disc. Offered alternate years; next offered 2009–2010. J. Reveal.
Analysis of the International Code of Botanical Nomenclature and its application to various plant groups.]

BIOPL 6560 Topics in Plant Evolution
Spring. 1 credit. Prerequisite: BIOPL 4480 or equivalent background in evolution, or written permission of instructor. Lab and disc. Offered alternate years. K. J. Niklas.
Series of selected topics to provide a background in plant evolution, paleobotanical literature, and evolutionary theory. Among the topics discussed are the origin of a terrestrial flora, the evolution of the seed plants, and the origin and adaptive radiation of the angiosperms.

BIOPL 7400 Plant Biology Seminar
Fall and spring. 0 credits (no official registration). Requirement for graduate students doing work in plant biology. W. L. Crepet.
Lectures on current research in plant biology, presented by visitors and staff.

BIOPL 7410 Problems in Plant Cell and Molecular Biology
Spring. 2 credits. Prerequisite: first- and second-year graduate students in Plant Cell and Molecular Biology Program. Disc.

Introduction to the research literature in plant molecular and cellular biology through weekly problem sets and discussions.

BIOPL 7420 Current Papers in Plant Biology
Fall or spring. 1 credit. Limited enrollment. Primarily for graduate students, with priority given to majors or minors in plant molecular biology. Prerequisite: for undergraduates, written permission of instructor. S-U grades only. Sem. Staff.

BIOPL 7430 Faculty Research in Plant Cell and Molecular Biology
Fall. 1 credit. Prerequisite: graduate standing or written permission from member of Plant Cell and Molecular Biology Program or from coordinator for undergraduates. Disc TBA. Staff.
Introduction for graduate students to the research being conducted by Cornell faculty in the Plant Cell and Molecular Biology Program.

BIOPL 7440 Graduate Research in Plant Cell and Molecular Biology
Fall or spring. 1 credit. Requirement for, and limited to, second-, third-, and fourth-year graduate students in Plant Cell and Molecular Biology. Sem. Staff.
Each student presents one seminar per year on his or her thesis research and then meets with the thesis committee members for evaluation.

BIOPL 7450 Seminar in Systematic Botany
Fall. 1 credit. Prerequisite: graduate standing or permission of instructor. S-U grades only. Sem. Bailey Hortorium staff.
Seminar with student presentations of current topics in systematics.

BIOPL 7460 Seminar in Systematic Botany: Student Research
Spring. 1 credit. Prerequisite: graduate standing or permission of instructor. Letter grades only. Sem. Bailey Hortorium staff.
Student-led seminar presentation based on his or her thesis research or a related topic.

BIOPL 7490 Graduate Research in Botany
Fall or spring. Variable credit; may be repeated for credit. S-U or letter grades. Staff.
Similar to BIOG 4990 but intended for graduate students who are working with faculty members on an individual basis.

Related Courses in Other Departments

Current Topics in Plant Molecular Ecology (BIOEE 6750)

Fungi (PLPA 3090)

Seaweeds, Plankton, and Seagrass: The Ecology and Systematics of Marine Plants (BIOSM 4490)

Fungal Biology (PLPA 6490)

Physiological Plant Ecology, Lectures and Laboratory (BIOEE 4660/468)

Plant Behavior–Induced Plant Responses to Biotic Stresses (BIOEE 4460)

Plant Cytogenetics Laboratory (PLBR 4460)

Undergraduate Research in Biology (BIOG 4990)

COURSES IN MARINE SCIENCE

Cornell offers an extensive listing of undergraduate courses in marine science.

Undergraduates interested in pursuing studies in marine science are encouraged to explore the undergraduate specialization in marine biology, the undergraduate specialization in ocean sciences, and the summer program of courses offered by the Shoals Marine Laboratory. For further information on all of these programs contact the Shoals Marine Laboratory Office, G14 Stimson Hall, or at www.sml.cornell.edu.

Undergraduate Specialization in Marine Biology

Biological sciences majors in the Ecology and Evolutionary Biology program of study have the option of specializing their program of study in the area of Marine Biology. This specialization is intended for students with interests in understanding the unique aspects of organismal biology in the marine environment. In addition to fulfilling the major and the ecology and evolutionary biology program of study requirements, students in marine biology are encouraged to enroll in the following courses:

1. BIOEE 1540 The Sea: An Introduction to Oceanography
2. BIOSM 3640 Field Marine Science or BIOSM 3750 Field Marine Biology and Ecology.
3. At least one 4000-level BIOSM field course at the Shoals Marine Laboratory, particularly BIOSM 4100 Animal Social Behavior, BIOSM 4130 Research in Marine Biology, BIOSM 4400 Marine Botany, BIOSM 4720 Marine Phylogenomics, and BIOSM 4770 Anatomy and Function of Marine Vertebrates.
4. BIOEE 4620 Marine Ecology

Undergraduate Specialization in Ocean Sciences

Science of Earth Systems majors have the option of specializing their program of study in the area of ocean sciences. This interdisciplinary specialization is intended for students with interests in understanding the interaction of biological, chemical, geological, and physical processes in ocean systems. In addition to fulfilling the Science of Earth Systems general requirements (see the SES program description in Interdisciplinary Centers, Programs, and Studies section of catalog), students in ocean sciences are required to take four advanced courses from the following list to fulfill their major requirements:

BIOSM 3080 Field Microbial Ecology

BIOSM 3090 Climates and Ecosystems

BIOSM 3100 Marine Symbiosis

BIOSM 3120 Biology of the Lobster

BIOSM 3290 Ecology of Animal Behavior

BIOSM 3640 Field Marine Science

BIOSM 3650 Underwater Research

BIOEE 3730 Biology of the Marine Invertebrates

BIOSM 3740 Field Ornithology

BIOSM 3750 Field Marine Biology and Ecology

BIOSM 3760 Marine Invertebrate Zoology (Note: Not same as BIOEE 3730)

BIOSM 3770 Diversity of Fishes

BIOSM 3820 Comparative Embryology and Life History Strategies

BIOSM 4130 Research in Marine Biology

BIOSM 4450 Forensics Science for Marine Biologists

BIOSM 4490 Marine Botany

BIOSM 4650 Sharks: The Biology, Evolution, and Conservation of Sharks and Their Allies

BIOSM 4770 Marine Vertebrates

BIOEE 4570 Limnology

BIOEE 4620 Marine Ecology

BIOEE 4780 Ecosystem Biology

BIOEE 4900 Topics in Marine Biology

EAS 3750 Sedimentology and Stratigraphy

EAS 4550 Geochemistry

EAS 4750 Special Topics in Oceanography

EAS 4790 Paleobiology

Students in both marine science specializations are exposed to an integrated program of study, emphasizing a natural progression of formal course work combined with ample opportunities for practical field experience.

SEA Semester

SEA courses must be taken concurrently. This program is run by Sea Education Association in Woods Hole, Mass. Contact SEA @ 800-552-3633.

BIOSM 3660 SEA: Introduction to Oceanography

BIOSM 3670 SEA: Introduction to Maritime Studies

BIOSM 3680 SEA: Introduction to Nautical Science

BIOSM 3690 SEA: Practical Oceanography I

BIOSM 3700 SEA: Practical Oceanography II

BIOSM: 3720 SEA: Practical Oceanography III

BIOSM 3780 SEA: Oceans and Climate: Oceans in the Global Carbon Cycle

BIOSM 3790 SEA: Ocean Science and Public Policy

BIOSM 3800 SEA: Oceanographic Field Methods

BIOSM 3810 SEA: Independent Research in Oceans and Climate

BIOSM 3620 SEA: Maritime History and Culture

BIOSM 3710 SEA: Marine Environmental History

SHOALS MARINE LABORATORY (BIOSM)

G14 Stimson Hall, 255–3717

Shoals Marine Laboratory (SML) provides a unique opportunity to explore marine sciences on Appledore Island, Maine, and island noted for its biota, geology, and history. SML has established a national reputation for excellence and is North America's largest marine field station focusing on undergraduate education.

The summer population of Appledore Island is limited to one hundred people at any one time. Students and faculty members literally and figuratively immerse themselves in their explorations, free from distractions common to most academic institutions. Because SML is a residential facility, a sense of community develops that makes courses and seminars at SML outstanding educational and intellectual experiences. Participants learn from and exchange ideas with a wide range of specialists whose primary interests are in marine sciences but whose perspectives often differ, providing fertile ground for lively discussions.

Credit courses at Shoals Marine Laboratory are full-time, intensive learning experiences. Courses may be taken sequentially, but **not** concurrently. A typical day combines lecture sessions, laboratory and field work, field trips to nearby islands or the mainland, and collecting and research excursions aboard the laboratory's 47-foot research vessel, *John M. Kingsbury*, or the 36-foot research vessel, *John B. Heiser.* Field experience is integral to all courses, using Appledore's extensive intertidal and subtidal zones and seabird colonies. Faculty, drawn from Cornell University, the University of New Hampshire, and other leading academic institutions, are selected based not only on their academic excellence but also on their ability to teach in the field. Many guest lecturers including engineers, coastal planners, and specialists from private industry, government, as well as the academic community visit Appledore during the season. The SML main administrative office is located at Cornell's Ithaca campus, G14 Stimson Hall. The office serves as an advising center for students interested in the marine sciences, maintains a browsing library with updated information on graduate study and career opportunities as well as on marine programs at other institutions.

The following marine sciences courses are currently administered by the Cornell Marine Programs Office. (Not all of these courses are offered each semester; consult the SML web site for current offerings: www.sml.cornell.edu.)

BIOSM 1110 A Marine Approach to Introductory Biology

Summer. 8 credits. Prerequisite: score of 4 or higher on AP Biology Exam (which fulfills introductory biology requirement for biology majors). Letter grades only. W. E. Bemis, J. B. Heiser, and D. Taylor.

A four-week course for pre-freshmen at Shoals Marine Lab (SML) on Appledore Island in the Gulf of Maine including daily fieldwork, boat trips, outdoor adventure, and practices for sustainable living. Intensive lectures, laboratory, and fieldwork occur in a learning environment emphasizing individual skill building, project design and execution, and collaboration with faculty and peers. We explore four major themes—ecology, behavior, development, and genomics—and connect them using examples from evolution. Social issues discussed range from global environmental change to sustainable fisheries, emerging infectious diseases, and stem cell research.

BIOSM 1230 Ocean Sciences

Summer. 4 credits. Prerequisite: permission of instructor. Letter grades only. Not offered 2009–2010. D. Taylor.

An inquiry-based, hands-on introduction to marine biology using the rocky intertidal and open sea as a natural laboratory. Students will learn the skills necessary for success in science courses: understanding disciplinary discourse; reading scientific papers critically; generating scientific hypotheses; designing experiments and interpreting data using basic statistics; and constructing, presenting and understanding data in graphs and tables. Students will learn and apply these skills to field exercises centered on textbooks, primary literature, lectures, seminars and discussions.

BIOSM 1600 The Oceanography of the Gulf of Maine

Summer. 3 credits. Limited to 24 students. S-U or letter grades. A two-week course offered aboard a SEA vessel and at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. For more details or an application, contact SML office, G14 Stimson Hall or web site (www.sml.cornell.edu) or Sea Education Association office, P.O. Box 6, Woods Hole, MA 02543, 800-552-3633 X 770 or web site: www.sea.edu. Daily lec, lab, and fieldwork for two weeks. S. Rensselaer, SEA and SML staff.

Exciting opportunity to explore the offshore and near-coastal environments of the Gulf of Maine for advanced high school students. Students spend 10 days aboard the Sea Education Association's sailing vessels round trip between Woods Hole, Mass., and the Isles of Shoals via Georges Bank and the Gulf of Maine. Besides operating the ship, students study the many characteristics of this unique ocean environment. Following the sea component, students spend seven days at the Shoals Marine Laboratory collecting data characteristic of the Isles of Shoals coastal environment.

BIOSM 1610 Introduction to Marine Science

Summer. 4 credits. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for two weeks. Not offered 2009–2010.

Allows students who are not biology majors to experience the breadth of the marine sciences under field conditions at an island laboratory. Aspects of biology, geology, earth science, chemistry, and physics are included. Specific topics include beach, salt marsh, tidal mud flat, tide pool, and benthic offshore environments; identification of marine plants and animals; chemical and physical oceanography; marine geology; and ecology of kelp beds and urchin barrens.

BIOSM 1620 Marine Environmental Science

Summer. 4 credits. Prerequisite: open to high school rising junior and senior students who have successfully completed two high school science courses. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for 14 days. M. Johnson.

Environmental studies have become an integral component of high school programs all around the country; however, opportunities to apply this course work to the marine environment are limited. Marine Environmental Science focuses on coastal marine habitats, with an emphasis on issues as they relate to global habitats and concerns. Laboratory exercises and fieldwork include explorations along Appledore Island's rocky intertidal zone and excursions to neighboring islands to observe harbor seal and seabird colonies. Offshore cruises include oceanographic sampling exercises and field trips to seabird and whale foraging grounds. Lectures and discussions expose MES students to topics ranging from fishes to fisheries, seaweeds to lobsters, and plankton to whales. Fundamental scientific research methods and equipment are introduced, and each student has the opportunity to be involved in group research projects.

BIOSM 2040 Biological Illustration

Summer. 2 credits. Prerequisite: none. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. B. Ober, C. Garrison, and J. Gibson.

General discussion of scientific publishing, illustration labeling, color techniques, and printing processes. Provides the scientist or science student a chance to experience several illustration techniques with the goal of obtaining an overview of scientific and wildlife illustrations. The student may choose a single technique to explore in depth. Course size is limited so that individual attention can be emphasized.

BIOSM 2100 Boats for Biologists

Summer. 2 credits. Prerequisite: open to all undergraduate and graduate students. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. W. E. Bemis.

Marine and freshwater biologists rely on boats—small and large—for transportation, environmental sampling, data collection, and other tasks. This course offers biologists at all stages of their careers a chance to learn basic boat handling, piloting, navigation, and common sampling techniques to enhance their opportunities for research and education. This course meets all certification requirements for basic small boat handling by state-specific agencies and National Association of Boating Law Administrators.

BIOSM 2250 Sustainability in the 21st Century

Summer. 4 credits. Prerequisite: open to all undergraduate and graduate students. Letter grades only. A two-week course offered at Shoals Marine Laboratory (SML) on Appledore Island in the Gulf of Maine. Cornell, UNH, SML faculty and staff.

Students will consider the challenges of institutionalizing sustainability. Through guest lectures and fieldwork, they will grapple with

challenges inherent to the field, devising strategies to enhance sustainability on Appledore Island. Topics include: systems thinking, food and fisheries, engineering and energy, and climate science.

BIOSM 2760 Seabird Ecology and Conservation

Summer. 2 credits. Prerequisite: one year college-level biology. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML) on Appledore Island in the Gulf of Maine. J. Ellis.

Combines lectures from specialists (e.g., ecologists and wildlife veterinarians) with a variety of field-based activities related to seabird ecology and conservation. Topics will include: seabird identification, behavioral studies, census techniques, population threats (e.g., fisheries bycatch, pollution), and restoration. A field trip to a nearby seabird restoration island will be included.

BIOSM 2770 Introduction to Marine Conservation Biology

Summer. 2 credits. Prerequisite: college-level introductory biology or equivalent. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. H. Weeks and K. Flessa.

Students will study introduction to the examination and analysis of marine biological resource conservation and management issues. Class will address principles and problems through readings, laboratory modeling exercises and lectures, including guests from the New England region, and explore potential pathways to success through readings and field trip.

BIOSM 3080 Field Microbial Ecology

Summer. 4 credits. Prerequisite: introductory biology or permission of instructor. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. E. Zettler and L. A. Zettler.

The microbial world dominates the biosphere in terms of biomass, diversity, and metabolic flexibility. This course will introduce students to collecting, observing, and identifying live representatives of these fascinating microbial organisms including bacteria, protists, fungi, and microscopic animals. Taxonomy and ecology of the basic groups of microorganisms will be covered while students learn to collect in the field for observation, experimentation and isolation.

BIOSM 3090 Coastal Ecology and Bioclimates

Summer. 4 credits. Prerequisite: one year college-level biology; background preferred in physics/physical geography. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. For more details or an application, contact SML office, G14 Stimson Hall. Daily lec, lab, and fieldwork for two weeks. G. Courtin.

Study of the fundamentals of organism-environment interaction developed through defining and measuring abiotic factors including solar radiation, temperature, atmospheric moisture, precipital wind, and currents. On-site exploration of the dynamics of meteorology and the role of abiotic and biotic factors in the life of coastal and marine plants and animals including humans.

BIOSM 3100 Marine Symbiosis

Summer. 4 credits. Prerequisite: one full year college-level biology. Recommended: background in microbiology or cell biology. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lecs and fieldwork for two weeks. SML faculty.

Introduction to the concepts of symbiosis as applied to marine organisms, with an emphasis on microbial symbionts. Students develop the ability to analyze symbioses using a comprehensive set of criteria, including duration, propagation, specificity, integration and modes of interaction. Morning lectures are followed by afternoons collecting, preparing and studying live specimens. Each student learns to use a variety of light microscopic techniques, and contributes, through fieldwork and by written reports, to a comprehensive survey of symbiotic associations on and around Appledore Island.

BIOSM 3120 Biology of the Lobster

Summer. 2 credits. Prerequisite: one year of college level biology. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. J. Factor.

An introduction to the biology of the American lobster, *Homarus americanus*. The course will include an overview of this ecologically and economically important species, as well as cover several major topics in depth, each taught by a lobster biologist expert in that field. Topics may include life history, larval development and metamorphosis, anatomy, physiological adaptation, fisheries and fishing methods, feeding mechanisms, ecology, and behavior. Course will include lecture, laboratory, discussion, and the natural field environment of Appledore Island.

BIOSM 3200 Functional Morphology of Marine Organisms

Summer. 4 credits. Prerequisite: one year introductory biology or one semester introductory biology, general zoology, and general botany. Letter grades only. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. F. Fish.

A study of the structure, form, and function of morphological adaptations in marine plants and animals as examined through a mechanical and ecological perspective. The course will investigate the biomechanics of marine organisms through lecture, laboratory demonstrations, and independent research projects.

BIOSM 3210 Anatomy and Function of Marine Vertebrates

Summer. 4 credits. Prerequisite: college-level introductory biology or equivalent. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. W. E. Bemis, EE&B faculty, and F. Fish.

Course includes introductions to vertebrate systematics, paleontology and evolution, vertebrate development, and functional morphology. Students will do comparative study of the anatomy of marine vertebrates, including: hagfishes; lampreys; sharks, skates, rays and chimaeras; ray finned fishes; lobe-finned fishes; marine reptiles, birds, and mammals. All 10 organ systems of vertebrates will be detailed in lecture and laboratory exercises. Dissection is required. Grades will be based on quizzes, essay exams, practical exams, class participation, and research projects.

BIOSM 3290 Ecology of Animal Behavior (also BIONB 3290)

Summer. 4 credits. Prerequisite: one year introductory college biology. Recommended: course work in ecology, psychology, or behavior. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for two weeks. H. Weeks, J. Waldvogel, and W. Kimler.

The ecological significance of behaviors of coastal organisms, with emphasis on field and laboratory research methods. Lectures and readings address the major subareas of behavior (communication, orientation, social behavior, foraging, predator avoidance, and sensory mechanisms). Each student engages in short-term behavioral observation and prepares a research proposal for studying a problem within the course subject area.

BIOSM 3640 Field Marine Science (FMS)

Summer. 8 credits. Prerequisite: one year college-level biology. S-U or letter grades. A four-week course offered twice each summer at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Students may not take FMS after taking FMBE (BIOSM 3750). Daily lec, lab, and fieldwork for four weeks. Three core faculty members assisted by up to 15 visiting lecturers, including representatives of governmental agencies. J. Factor, R. Zechman, S. Morris, W. E. Bemis, and E. Zettler.

Designed for the student who desires an initial overview of the marine sciences, this course emphasizes living material in natural habitats. Most of the course work is concerned with the biology of intertidal plants and animals, biological oceanography, ichthyology, and fisheries. Attention is also given to introductory physical and chemical oceanography and marine geology. Marine ecology and the effects of human activity on the marine environment are included. Students apply this knowledge by conducting a transect study toward the end of the course. FMS places emphasis on ichthyology, fisheries biology, general oceanography (biological, physical, and chemical), and marine geology. FMBE (BIOSM 3750) places an additional emphasis on ecology, especially in the intertidal zone; ecological, evolutionary and physiological adaptations of marine organisms; and field experiments.

BIOSM 3650 Underwater Research

Summer. 4 credits. Prerequisites: one year college-level biology, recognized SCUBA certification, and medical exam. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec and fieldwork for two weeks. J. Coyer, J. Grabowski, and E. Calvert.

Covers the philosophy of research, hypothesis testing and experimental design, sampling methods, various underwater techniques, diving physics and physiology, and use of dive tables. Emphasizes subtidal ecological research. Requirements include critical evaluation of several journal articles and production of a research proposal.

BIOEE 3730 Biology of the Marine Invertebrates
Fall (but course must be taken previous summer at Shoals Marine Laboratory [SML]), three-week, full-time course. 5 credits (students enroll for credit during fall semester). Limited to 24 students. Prerequisites: one year introductory biology for majors; permission of faculty because off campus. Letter grades only. Daily and evening lec, lab, and fieldwork. Offered alternate years. C. D. Harvell.

BIOSM 3740 Field Ornithology
Summer. 4 credits. Prerequisite: one year college-level biology. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec and fieldwork for two weeks. D. Bonter.
Introduction to field ornithology focusing on the biology, ecology, and behavior of the avifauna on the Isles of Shoals. Focuses on fieldwork designed to observe and study many concepts frequently taught in the classroom setting including territoriality, breeding biology, and survivorship. Students learn and apply numerous ornithological field methods including various census techniques, territory mapping, banding, behavioral observations, and creating a field notebook.

BIOSM 3750 Field Marine Biology and Ecology (FMBE)
Summer. 8 credits. Prerequisites: one full year college-level biology. S-U or letter grades. A four-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for four weeks. K. A. Miller and C. Sikkon.
Designed for students seeking an introduction to the marine sciences and marine ecology; FMBE emphasizes fieldwork in natural habitats. Examines aspects of the biology and ecology of marine organisms, including intertidal plants and invertebrates, fishes, marine mammals and birds, biological oceanography, and human impacts on the marine environment. FMBE places a special emphasis on the ecology of the intertidal zone and ecological, evolutionary, and physiological adaptations of marine organisms. Students may not take FMBE after taking FMS (BIOSM 3640).

[BIOSM 3760 Marine Invertebrate Zoology
Summer. 6 credits. Prerequisite: one year introductory biology and permission of instructors. Students may not take BIOSM 3760 after taking BIOEE 3730. S-U or letter grades. A three-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for three weeks. Offered alternate years; next offered summer 2010. J. Morin.
Introduction to the biology and evolution of the major invertebrate phyla, concentrating on marine representatives. Emphasizes the evolution of form and function, and the ecology, behavior, physiology, chemical ecology, and natural history of invertebrates. Appledore Island's unique location provides an excellent venue for the study of freshly collected and *in situ* representatives of most of the major phyla.]

BIOSM 3770 Diversity of Fishes
Summer. 6 credits. Prerequisite: one full year college-level biology. Recommended: background in vertebrate biology. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lecs and fieldwork for two weeks. B. Collette.
Intensive lecture, laboratory, and field course. Lectures cover the basic anatomy and physiology of fishes with examples drawn from a wide variety of fishes from throughout the world. The course emphasizes the diversity of fishes in two aspects, diversity of evolutionary solutions to problems faced by fishes and the great diversity of different types of fishes that inhabit the world. Laboratory exercises cover the anatomy and osteology of teleost fishes and identification of local species. Each student selects a different local species of teleost fish to study and dissect and prepares a comprehensive paper on its morphology, soft anatomy, and osteology.

BIOSM 3820 Comparative Embryology and Life History Strategies
Summer. 2 credits. Prerequisite: introductory biology or equivalent. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. W. E. Bemis, EE&B faculty.
Includes fieldwork, culture methods, histology, microscopy, and photomicrography. Students will do comparative study of invertebrate and vertebrate embryos in the context of life-history strategies. This course emphasizes marine species from the Gulf of Maine. Topics include; gametogenesis, fertilization, cleavage, gastrulation, organogenesis, cytodifferentiation and larval biology. Student projects will detail embryology and life history of specific species.

BIOSM 4100 Animal Social Behavior
Summer. 2 credits. Prerequisite: introductory biology. Letter grades only. A one-week course offered at Shoals Marine Laboratory (SML) on Appledore Island in the Gulf of Maine. T. Seeley, P. Sherman, and J. Shellman Sherman.
An introduction to the study of animal behavior in the field by focusing on the behavior of the herring gulls nesting on Appledore Island. Topics will include natural selection and behavior, levels of analysis, animal communication, territoriality, kin recognition, orientation, and mating systems. *The Herring Gull's World*, the classic book of Nobel Laureate Niko Tinbergen, will be read and discussed. Methods of measuring behavior and designing experiments will be taught, and students will conduct individual research projects.

BIOSM 4130 Research in Marine Biology
Summer. 6 credits. Prerequisite: one year college-level biology. Recommended: experience in ecology or physiology. S-U or letter grades. A three-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for three weeks. D. Taylor, D. Fudge, and A. Todgham.
A hands-on course in which students explore the marine environment around Appledore Island via field and laboratory experiments of their own design. This course is unique in that students learn practical skills that are required of all biologists, such as generating hypotheses, experimental design, data collection, statistical analysis, group decision-making, writing scientific papers, and communicating results to others. The class will work together on several experiments inspired by student observations, primary literature, lectures, and data collected by previous classes. Phenomena investigated in previous years include: predator-prey interactions, vertical migration in zooplankton, biomechanical design, foraging behavior, photosynthesis, and adaptation to intertidal stressors such as desiccation, temperature, and wave action. Students will gain practical experience with laboratory, field, and remote sensing equipment, and may work with a diverse range of marine organisms including vertebrates, invertebrates and algae. Each student will take responsibility for writing up the results from one experiment and will present the results in a scientific symposium at the end of the course. This course is highly recommended for undergraduates interested in independent research or considering graduate education in biology, as well as science educators seeking experience in inquiry-based learning.

BIOSM 4450 Forensic Science for Marine Biologists
Summer. 2 credits. Prerequisite: satisfactory completion of college-level course in biology, ecology, or marine science. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. W. Lord, R. Haebler, R. Kenney, W. Rodriguez, and I. Sidor.
Forensic science represents the unique merging of scientific insight and the law. Forensic Science for Marine Biologists provides a field-oriented introduction to the forensic science domain and the utilization of marine biology within the justice system. Students receive comprehensive instruction concerning the recognition, documentation, collection, and preservation of physical evidence. Additionally, students develop practical incident response, scene management, and forensic teamwork skills.

BIOSM 4490 Marine Botany
Summer. 4 credits. Prerequisite: BIOSM 3640 or one year introductory biology. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for two weeks. R. Zechman.
Overview of the major marine algal groups, including aspects of anatomy, morphology, development, life histories, physiology, and use. Laboratories and fieldwork emphasize relationships between distribution and major environmental parameters and involve student projects.

BIOSM 4650 Sharks: The Biology, Evolution, and Conservation of Sharks and Their Allies
Summer. 2 credits. Prerequisite: vertebrates or comparative anatomy and ichthyology or permission of SML director. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. D. Dagit and W. E. Bemis.
The last 30 years have produced an explosion of new information on the biology of the approximately 1,000 living species of sharks, skates, rays, and chimaeras, which collectively make up the group Chondrichthyes. This

course will cover advanced topics in the evolution, diversity, anatomy, functional morphology, neurobiology, sensory systems, behavior, reproduction, development, and conservation of cartilaginous fishes.

BIOSM 4720 Marine Phylogenomics
Summer. 4 credits. Prerequisite: one year introductory biology. Recommended: genetics and/or cell biology with laboratory components. Helpful: evolutionary biology, ecology vertebrate/ invertebrate zoology. Letter grades only. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. A. Shedlock.
An introduction to basic concepts in systematic biology, evolutionary genetics, molecular ecology, and conservation biology emphasizing the natural history of marine organisms. Students integrate field sampling techniques, taxonomy, and curation of specimens from Appledore Island and surrounding waters with molecular diagnostics completed in the laboratory. Standard methods for DNA purification, amplification, sequencing, and genotyping are used to address questions about population structure, kinship, and species phylogeny.

BIOSM 4770 Marine Vertebrates
Summer. 6 credits. Prerequisites: vertebrate biology course or equivaent course at level from which applicant can demonstrate knowledge of basic vertebrate anatomy, physiology, and systematics, or permission of instructor. S-U or letter grades. A three-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for three weeks. J. Heiser.
Topics in marine vertebrate biology emphasizing laboratory studies, field collections or observations, and readings from the current literature. Topics include systematics of fishes of the Gulf of Maine; elasmobranch physiology; interpretation of life history and parameters from otolith microstructure; teleost skeletomuscular structure and function; population biology and the contemporary Gulf of Maine fishery; Mesozoic marine reptiles; the biology of sea turtles in cold water; coloniality in sea birds; avian adaptations to life at sea; evolution and systematics of marine mammals; diving physiology; and ecology and conservation of existing marine mammal populations. Dissection of vertebrate animals is a part of one or more laboratory sessions.

BIOSM 4950 Research Methods in Marine Biology
Summer. 1 credit. Corequisite: BIOSM 4990 or permission of instructor. Primarily for undergraduates. An eight-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Weekly sem for eight weeks. SML faculty.
Seminar course on research methodology, experimental design, statistical analyses, and scientific writing. The course is designed to assist students in the research they are conducting while enrolled in BIOSM 4990.

BIOSM 4990 Research in Biology
Summer. Variable credit; 2 credits per seven days on site. A three-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. SML faculty.
Section A: Independent Biological Research: Independent study with a member of the Shoals Marine Laboratory core faculty, based on student faculty interest and available facilities. A short proposal of research must be sent with application materials.

[BIOSM 6500 Field Marine Ecology and Environmental Science for Teachers
Summer. 2 credits. Prerequisites: one year college-level biology. Recommended: teaching experience. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec and fieldwork for one week. SML faculty.
Intended for teachers of grades 6–12 but also open to undergraduate junior and senior students interested in teaching. Teachers develop hands-on, experiential approaches to the marine sciences, with an emphasis on coastal and environmental issues. Extensions to freshwater ecology also are included. Fieldwork is emphasized, with numerous excursions to the rocky intertidal and with off-shore ocean sampling. Lectures focus on biodiversity, adaptations, predator-prey interactions, environmental sustainability, and how to engage and motivate students with aquatic projects.]

[BIOSM 6990 Research in Biology for Teachers
Summer. 2 credits per week. Prerequisite: BIOSM 6500. One-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine.
Opportunity for teachers who have taken BIOSM 6500 to return to Shoals to pursue in greater depth a topic of their choosing under the direction of the BIOSM 6500 faculty.]

SEA Semester

Sea Education Association (SEA) offers a semester-length sequence of courses designed to provide college undergraduates with a thorough academic, scientific, and practical understanding of the sea. *This sequence is repeated approximately once every two months throughout the year.* Students spend the first half of SEA Semester (a six-week shore component) in Woods Hole, Mass., receiving instruction in oceanography, nautical science, and maritime studies. The second half of SEA Semester (a six-week sea component) is spent at sea aboard the SSV *Robert C. Seamans* or the SSV *Corwith Cramer*. Enrollment is open to both men and women judged capable of benefiting from SEA semester; a student must have successfully completed **at least one college-level laboratory science course** (or its equivalent) in order to be admitted to SEA Semester or SEA Summer Session. **No prior sailing experience is necessary**. Cornell students enrolled in the SEA Semester must take the entire sequence.

For more information, contact Sea Education Association, P.O. Box 6, Woods Hole, MA 02543 or call 800–552–3633 ext. 770. Program costs are to be paid in place of regular Cornell tuition and fees.

Instructors for the SEA Semester include faculty of the Sea Education Association and the Woods Hole Oceanographic Institution and others.

SEA Basic Semester

BIOSM 3660 SEA Introduction to Oceanography
3 credits. Corequisites: BIOSM 3670 and 3680.
Survey of the characteristics and processes of the global ocean. Introduces oceanographic concepts and develops them from their bases in biology, physics, chemistry, and geology. Provides a broad background in oceanography with special attention to areas pertinent to the subsequent cruise. Guest lecturers from the Woods Hole research community interpret current trends and activities in this rapidly evolving field. Students develop individual projects to be carried out at sea.

BIOSM 3670 SEA Introduction to Maritime Studies
3 credits. Corequisites: BIOSM 3660 and 3680.
Interdisciplinary consideration of our relationship with the marine environment. Covers the elements of maritime history, law, literature, and art necessary to appreciate our marine heritage and to understand the political and economic problems of contemporary maritime affairs.

BIOSM 3680 SEA Introduction to Nautical Science
3 credits. Corequisites: BIOSM 3660 and 3670.
An introduction to the technologies of operation at sea. The concepts of navigation (piloting, celestial and electronic), naval architecture, ship construction, marine engineering systems, and the physics of sail are taught from their bases in astronomy, mathematics, and physics. Provides the theoretical foundation for the navigation, seamanship, and engineering that students employ at sea.

BIOSM 3690 SEA Practical Oceanography I
4 credits. Prerequisite: BIOSM 3660.
Theories and problems raised in the shore component are tested in the practice of oceanography at sea. Students are introduced to the tools and techniques of the practicing oceanographer. During lectures and watch standing, students are instructed in the operation of basic oceanographic equipment; in the methodologies involved in the collection, reduction, and analysis of oceanographic data; and in the attendant operations of a sailing oceanographic research vessel.

BIOSM 3700 SEA Practical Oceanography II
4 credits. Prerequisites: BIOSM 3680 and 3690.
Building on the experience of Practical Oceanography I, students assume increasing responsibility for conducting oceanographic research and overseeing operations of the vessel. The individual student is ultimately responsible directly to the chief scientist and the master of the vessel for the safe and orderly conduct of research activities and related operations of the vessel. Each student undertakes an individual research project designed during the shore component.

BIOSM 3720 SEA Practical Oceanography III
Summer. 3 credits. Prerequisites: BIOSM 3660, 3670, and 3680.
Theories and problems raised in class are tested in the practice of oceanography at sea. During lectures and watch standing, students are instructed in the operation of basic oceanographic equipment, in the methodologies involved in the collection, analysis, and reduction of oceanographic data, and in the attendant operations of sailing an oceanographic research vessel. Group research projects are completed.

SEA Oceans and Climate Semester

BIOSM 3680 SEA Introduction to Nautical Science

BIOSM 3780 SEA Oceans and Climate: Oceans in the Global Carbon Cycle
Fall, spring. 4 credits. Prerequisite: 3 lab science courses or permission of instructor. SML faculty.
This course examines the role of the oceans in the climate system, addressing topics such as the global carbon cycle, the thermohaline circulation, and aspects of global change including warming and sea level rise.

BIOSM 3790 SEA Ocean Science and Public Policy (HA)
Fall, spring. 3 credits. SEA faculty.
This course seeks to provide students with a fundamental understanding of the intersection between climate change and governmental policy and the interrelationship between science and governmental policy. After an introduction to the development of maritime law and sovereignty on the high seas, students will examine why societies funded oceanic research.

BIOSM 3800 SEA Oceanographic Field Methods
Fall, spring. 3 credits. Prerequisite: successful completion of BIOSM 3780. SEA faculty.
This course introduces students to all aspects of oceanographic fieldwork. Students learn practical skills in the operating principles and safe deployment of oceanographic instrumentation. Skills acquired enable students to carry out an independent research project.

BIOSM 3810 SEA Independent Research in Oceans and Climate
Fall, spring. 4 credits. Prerequisite: successful completion of BIOSM 3780. SEA faculty.
This course provides upper-level study focused on oceanography and climate, including the design and completion of an independent research project that is comparable in scope to an undergraduate senior research thesis.

SEA: Documenting Change in the Caribbean Semester

BIOSM 3620 SEA Maritime History and Culture (CA) (HA)
Fall, spring. 4 credits. SEA faculty.
In this course, students will explore political, cultural and social changes in the Caribbean since just before Europeans arrived at the end of the 15th century. Student will see how the physical nature of the region has influenced patterns of settlement and development and the impact of European expansion.

BIOSM 3660 SEA Practical Oceanography I

BIOSM 3680 SEA Introduction to Nautical Science

BIOSM 3700 SEA Practical Oceanography II

BIOSM 3710 SEA Marine Environmental History (CA) (LA)
Fall, spring. 4 credits. SEA faculty.
This course is designed to explore the interaction of ecological factors in ocean, coastal and island environments; the impact of human actions on those environments; and the need for local, regional and international responses and strategies to mitigate and manage that impact.

FACULTY ROSTER

New York State College of Agriculture and Life Sciences

Adler, Kraig K., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior
Agrawal, Anurag, Ph.D., U. of California, Davis. Assoc. Prof., Ecology and Evolutionary Biology/Entomology
Alani, Eric E., Ph.D., Harvard U. Assoc. Prof., Molecular Biology and Genetics
Anderson, John M., Ph.D., New York U. Prof. Emeritus, Molecular Biology and Genetics
Angert, Esther R., Ph.D., Indiana U. Assoc. Prof., Microbiology
Barbash, Daniel A., Ph.D., U. of California, Berkeley. Asst. Prof., Molecular Biology and Genetics
Bates, David M., Ph.D., U. of California, Los Angeles. Prof. Emeritus, Plant Biology (Bailey Hortorium)
Bemis, William E., Ph.D., U. of California, Berkeley. Prof., Ecology and Evolutionary Biology/Shoals Marine Laboratory
Bruns, Peter J., Ph.D., U. of Illinois. Prof. Emeritus, Molecular Biology and Genetics
Cade, Thomas J., Ph.D., U. of California, Los Angeles. Prof. Emeritus, Ecology and Evolutionary Biology
Calvo, Joseph M., Ph.D., Washington State U. William T. Keeton Professor Emeritus in Biological Sciences, Molecular Biology and Genetics
Chabot, Brian F., Ph.D., Duke U. Prof., Ecology and Evolutionary Biology
Clayton, Roderick K., Ph.D., California Inst. of Technology. Prof. Emeritus, Plant Biology
Crepet, William L., Ph.D., Yale U. Prof., Plant Biology (Bailey Hortorium)*
Davies, Peter J., Ph.D., U. of Reading (England). Prof., Plant Biology
Davis, Jerrold I., Ph.D., U. of Washington. Assoc. Prof., Plant Biology (Bailey Hortorium)
Dhondt, André A., Ph.D., Ghent State U. (Belgium). Edwin H. Morgens Professor of Ornithology, Ecology and Evolutionary Biology/Laboratory of Ornithology
Dondero, Norman C., Ph.D., Cornell U. Prof. Emeritus, Microbiology
Doyle, Jeffrey J., Ph.D., Indiana U. Prof., Plant Biology (Bailey Hortorium)
Dress, William J., Ph.D., Cornell U. Prof. Emeritus, Plant Biology (Bailey Hortorium)
Eisner, Thomas, Ph.D., Harvard U. Jacob Gould Schurman Professor Emeritus, Neurobiology and Behavior/Ecology and Evolutionary Biology*
Emlen, Stephen T., Ph.D., U. of Michigan. Jacob Gould Schurman Professor, Neurobiology and Behavior
Feeny, Paul P., Ph.D., Oxford U. (England). Prof., Ecology and Evolutionary Biology
Fitzpatrick, John W., Ph.D., Princeton U. Prof., Ecology and Evolutionary Biology/ Laboratory of Ornithology
Flecker, Alexander S., Ph.D., U. of Maryland. Assoc. Prof., Ecology and Evolutionary Biology
Fox, Thomas D., Ph.D., Harvard U. Prof., Molecular Biology and Genetics
Ghiorse, William C., Ph.D. Rensselaer Polytechnic Inst. Prof., Microbiology
Gibson, Jane, Ph.D., U. of London (England). Prof. Emeritus, Molecular Biology and Genetics
Goldberg, Michael L., Ph.D., Stanford U. Prof., Molecular Biology and Genetics
Hanson, Maureen R., Ph.D., Harvard U. Prof., Molecular Biology and Genetics/Liberty Hyde, Prof., Plant Biology
Harrison, Richard G., Ph.D., Cornell U. Prof., Ecology and Evolutionary Biology
Harris-Warrick, Ronald M., Ph.D., Stanford U. Prof., Neurobiology and Behavior
Harvell, C. Drew, Ph.D., U. of Washington. Prof., Ecology and Evolutionary Biology
Hay, Anthony, Ph.D., U. of California. Assoc. Prof., Microbiology
Helmann, John D., Ph.D., U. of California, Berkeley. Prof., Microbiology
Henry, Susan, Ph.D., U. of California, Berkeley. Prof., Molecular Biology and Genetics and Dean CALS
Hopkins, Carl D., Ph.D., Rockefeller U. Prof., Neurobiology and Behavior
Howarth, Robert W., Ph.D., Massachusetts Inst. of Technology/Woods Hole Oceanographic Institution. David R. Atkinson Professor of Ecology and Environmental Biology, Ecology and Evolutionary Biology
Hua, Jian, Ph.D., California Inst. of Technology. Asst. Prof., Plant Biology
Ingram, John W., Ph.D., U. of California, Berkeley. Prof. Emeritus, Plant Biology (Bailey Hortorium)
Jagendorf, André T., Ph.D., Yale U. Liberty Hyde Bailey Professor of Plant Physiology Emeritus, Plant Biology
Kemphues, Kenneth J., Ph.D., Indiana U. Prof., Molecular Biology and Genetics
Kessler, André, Ph.D., Max Planck Inst. for Chemical Ecology/Friedrich Schiller U. of Jena (Germany). Asst. Prof., Ecology and Evolutionary Biology/Boyce Thompson Inst. for Plant Research
Kingsbury, John M., Ph.D., Harvard U. Prof. Emeritus, Plant Biology
Kraus, W. Lee, Ph.D., U. of Illinois. Assoc. Prof., Molecular Biology and Genetics
Lis, John T., Ph.D., Brandeis U. Barbara McClintock Professor of Molecular Biology and Genetics
Lovette, Irby J., Ph.D., U. of Pennsylvania. Assoc. Prof., Ecology and Evolutionary Biology/Laboratory of Ornithology
Luckow, Melissa A., Ph.D., U. of Texas, Austin. Assoc. Prof., Plant Biology (Bailey Hortorium)
MacDonald, Russell E., Ph.D., U. of Michigan. Prof. Emeritus, Molecular Biology and Genetics
MacIntyre, Ross J., Ph.D., Johns Hopkins U. Prof., Molecular Biology and Genetics
Madsen, Eugene L., Ph.D., Cornell U. Assoc. Prof., Microbiology
Marks, Peter L., Ph.D., Yale U. Prof. Emeritus, Ecology and Evolutionary Biology

McCune, Amy R., Ph.D., Yale U. Prof., Ecology and Evolutionary Biology
Morin, James G., Ph.D., Harvard U. Prof., Ecology and Evolutionary Biology
Mortlock, Robert P., Ph.D., U. of Illinois. Prof. Emeritus, Microbiology
Nasrallah, June B., Ph.D., Cornell U. Prof., Plant Biology
Nasrallah, Mikhail E., Ph.D., Cornell U. Prof., Plant Biology
Naylor, Harry B., Ph.D., Cornell U. Prof. Emeritus, Microbiology
Niklas, Karl J., Ph.D., U. of Illinois. Prof., Plant Biology
Nixon, Kevin C., Ph.D., U. of Texas, Austin. Assoc. Prof., Plant Biology (Bailey Hortorium)
Owens, Thomas G., Ph.D., Cornell U. Assoc. Prof., Plant Biology
Paolillo, Dominick J., Jr., Ph.D., U. of California, Davis. Prof. Emeritus, Plant Biology
Parthasarathy, Mandayam V., Ph.D., Cornell U. Prof. Emeritus, Plant Biology
Peters, Joseph, Ph.D., U. of Maryland. Asst. Prof., Microbiology
Raguso, Robert A., Ph.D., U. of Michigan. Assoc. Prof., Neurobiology and Behavior
Reeve, H. Kern, Ph.D., Cornell U. Prof., Neurobiology and Behavior
Roberts, Jeffrey W., Ph.D., Harvard U. Robert J. Appel Professor of Cellular and Molecular Biology, Molecular Biology and Genetics
Rodriguez, Eloy, Ph.D., U. of Texas. Prof., Plant Biology (Bailey Hortorium)
Root, Richard B., Ph.D., U. of California, Berkeley. Prof. Emeritus, Ecology and Evolutionary Biology/Entomology
Rose, Jocelyn, Ph.D., U. of California, Davis. Assoc. Prof., Plant Biology
Russell, James B., Ph.D., U. of California, Davis. Prof., Microbiology
Scanlon, Michael, Ph.D., Iowa State U. Assoc. Prof., Plant Biology
Seeley, Jr., Harry W., Ph.D., Cornell U. Prof. Emeritus, Microbiology
Shalloway, David I., Ph.D., Massachusetts Inst. of Technology. Greater Philadelphia Prof., Molecular Biology and Genetics
Shapleigh, James P., Ph.D., U. of Georgia. Assoc. Prof., Microbiology
Tye, Bik-Kwoon, Ph.D., Massachusetts Inst. of Technology. Prof., Molecular Biology and Genetics
Uhl, Charles H., Ph.D., Cornell U. Prof. Emeritus, Plant Biology
Uhl, Natalie W., Ph.D., Cornell U. Prof. Emeritus, Plant Biology (Bailey Hortorium)
Van Wijk, Klaas J., Ph.D., Groningen U. (The Netherlands). Assoc. Prof., Plant Biology
Vogt, Volker M., Ph.D., Harvard U. Prof., Molecular Biology and Genetics
Walcott, Charles, Ph.D., Cornell U. Prof., Neurobiology and Behavior
Wayne, Randy O., Ph.D., U. of Massachusetts. Assoc. Prof., Plant Biology
Winans, Stephen C., Ph.D., Massachusetts Inst. of Technology. Prof., Microbiology
Winkler, David W., Ph.D., U. of California, Berkeley. Prof., Ecology and Evolutionary Biology
Zahler, Stanley A., Ph.D., U. of Chicago. Prof. Emeritus, Molecular Biology and Genetics
Zinder, Stephen H., Ph.D., U. of Wisconsin. Prof., Microbiology

Other Teaching Personnel

Blankenship, James E., M.S., Cornell U. Sr. Lec., Molecular Biology and Genetics
Calvo, Rita A., Ph.D., Cornell U. Courtesy Sr. Lec., Molecular Biology and Genetics
Chen, Kuei-chiu, Ph.D., New York U. Lec., Neurobiology and Behavior
Ely, Susan, Ph.D., Tufts U. Sr. Lec., Molecular Biology and Genetics
Hester, Laurel, Ph.D., U. Michigan. Lec., Neurobiology and Behavior
Lorr, Nancy, Ph.D., U. of Oregon. Lec., Physiology
McGuire, Betty A., Ph.D., U. of Massachusetts. Sr. Lec., Ecology and Evolutionary Biology
Merkel, Susan, M.S., Cornell U. Sr. Lec., Microbiology
Nivison, Helen T., Ph.D., U. of California, Davis. Sr. Lec., Molecular Biology and Genetics
Rehkugler, Carole M., M.S., Cornell U. Sr. Lec., Microbiology
Silva, Thomas, Ph.D., Cornell U. Sr. Lec., Plant Biology
Southard, Laurel E., M.S., Tulane U. Lec., Undergraduate Biology

Joint Appointees

Bloom, Stephen E., Prof., Veterinary/Microbiology and Immunology
Bradbury, Jack, Prof., Neurobiology and Behavior/Library of Natural Sounds
Brutnell, Thomas, Prof., Plant Breeding/Plant Biology
Doyle, Jeffrey J., Prof., Plant Biology (Bailey Hortorium)/Plant Biology General
Foote, Robert H., Jacob Gould Schurman Prof. Emeritus, Animal Science/Physiology
Giovannoni, James G., Adjunct Asst. Prof., USDA Science and Education Administration/Plant Biology
Hanson, Maureen, Prof., Molecular Biology and Genetics/Plant Biology
Hrazdina, Geza, Prof. Emeritus, Food Science and Technology Geneva/Plant Biology Ithaca
Jahn, Margaret M., Assoc. Prof., Plant Breeding/Plant Biology
Jander, Georg, Adjunct Asst. Prof., Boyce Thompson Inst./Plant Biology
Kochian, Leon V., Adjunct Prof., USDA Science and Education Administration/Plant Biology
Korf, Richard P., Prof. Emeritus, Plant Pathology/Plant Biology (Bailey Hortorium)
Kresovich, Stephen, Prof., Plant Breeding/Plant Biology
Liebherr, James K., Assoc. Prof., Entomology/Plant Biology (Bailey Hortorium)
McClure, Polley A., Prof., Information Technologies/Ecology and Evolutionary Biology
McCouch, Susan R., Assoc. Prof., Plant Breeding/Plant Biology
Pimentel, David, Prof. Emeritus, Entomology/Ecology and Evolutionary Biology
Rossman, Michael J., Adjunct Prof., Purdue U./Molecular Biology and Genetics
Stern, David B., Adjunct Prof., Boyce Thompson Institute/Plant Biology
Tanksley, Steven, Prof., Plant Breeding/Liberty Hyde Bailey Prof., Plant Biology
Thaler, Jennifer S., Assoc. Prof., Entomology/Ecology and Evolutionary Biology
Thompson, John F., Adjunct Prof., USDA Science and Education Administration/Plant Biology
Vehrencamp, Sandra, Prof., Neurobiology and Behavior/Library of Natural Sounds
Wang, Haiyang, Adjunct Asst. Prof., Boyce Thompson Inst./Plant Biology

College of Arts and Sciences

Adkins-Regan, Elizabeth, Ph.D., U. of Pennsylvania. Prof., Neurobiology and Behavior/Psychology
Aquadro, Charles F., Ph.D., U. of Georgia. Charles A. Alexander Professor of Biological Sciences, Molecular Biology and Genetics/Ecology and Evolutionary Biology
Bass, Andrew H., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior
Blackler, Antonie W., Ph.D., U. of London (England). Prof., Molecular Biology and Genetics
Booker, Ronald, Ph.D., Princeton U. Assoc. Prof., Neurobiology and Behavior
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Brown, William J., Ph.D., U. of Texas Health Science Center, Dallas. Prof., Molecular Biology and Genetics
Clark, Andrew G., Ph.D., Stanford U. Jacob Gould Schurman Professor of Population Genetics, Molecular Biology and Genetics/Ecology and Evolutionary Biology
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Emr, Scott, Ph.D., Harvard U. Frank H.T. Rhodes Class of '56 Endowed Director of the new Cornell Institute of Cell and Molecular Biology
Feigenson, Gerald W., Ph.D., California Inst. of Technology. Prof., Molecular Biology and Genetics
Fetcho, Joseph R., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior
Finlay, Barbara, Ph.D., Massachusetts Inst. of Technology. Prof., Psychology
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Goodale, Christine L., Ph.D., U. of New Hampshire. Asst. Prof., Ecology and Evolutionary Biology
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Hess, George P., Ph.D., U. of California, Berkeley. Prof., Molecular Biology and Genetics
Hinkle, Peter C., Ph.D., New York U. Prof., Molecular Biology and Genetics
Howland, Howard C., Ph.D., Cornell U. Prof., Neurobiology and Behavior/Biomedical Sciences
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Huffaker, Tim C., Ph.D., Massachusetts Inst. of Technology. Prof., Molecular Biology and Genetics

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Pleiss, Jeffrey, Ph.D., U. of Colorado. Asst. Prof., Molecular Biology and Genetics
Power, Alison G., Ph.D., U. of Washington. Prof., Ecology and Evolutionary Biology/ Science and Technology Studies
Provine, William B., Ph.D., U. of Chicago. Andrew H. and James S. Tisch Distinguished University Professor, Ecology and Evolutionary Biology/History
Schimenti, John C., Ph.D., U. of Cincinnati. Prof., Molecular Biology and Genetics, and Dir., Vertebrate Genomics
Seeley, Thomas D., Ph.D., Harvard U. Prof., Neurobiology and Behavior
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Sparks, Jed P., Ph.D., Washington State U. Assoc. Prof., Ecology and Evolutionary Biology
Tumbar, Tudorita, Ph.D., U. of Illinois, Urbana-Champaign. Asst. Prof., Molecular Biology and Genetics
Turgeon, Robert, Ph.D., Carleton U. (Canada). Prof., Plant Biology
Wallace, Bruce, Ph.D., Columbia U. Prof. Emeritus, Molecular Biology and Genetics
Wilson, David B., Ph.D., Stanford U. Prof., Stephen H. Weiss Presidential Fellow, Biochemistry, Molecular Biology and Genetics
Wolfner, Mariana F., Ph.D., Stanford U. Prof., Molecular Biology and Genetics
Zamudio, Kelly R., Ph.D., U. of Washington. Assoc. Prof., Ecology and Evolutionary Biology

Other Teaching Personnel

Balko, Elizabeth A., Ph.D., College of Environmental Science and Forestry. Sr. Lec., Plant Biology
Johnson, Bruce R., Ph.D., Boston U. Sr. Lec., Neurobiology and Behavior
Land, Bruce R., Ph,.D., Cornell U., Sr. Lec., Neurobiology and Behavior

Joint Appointees

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Likens, Gene E., Adjunct Prof., Institute of Ecosystem Studies/Ecology and Evolutionary Biology

College of Veterinary Medicine

Alcaraz, Ana, D.V.M., Ph.D., Cornell U. Lec., Biomedical Sciences
Beyenbach, Klaus W., Ph.D., Washington State U. Prof., Biomedical Sciences
Bezuidenhout, Abraham, D.V.Sc., U. of Pretoria (South Africa), Sr. Lec., Biomedical Sciences
Buckles, Elizabeth, D.V.M., Ph.D., U. of Wisconsin. Asst. Prof., Pathology
Catalfamo, James, M.S., Ph.D., Union Coll. Sr. Res. Assoc., Population Medicine and Diagnostic Services
Chuang, Huai-hu, Ph.D., U. of California. Asst. Prof., Molecular Physiology
Cohen, Paula, Ph.D., U. of London (England). Asst. Prof., Genetics
Farnum, Cornelia E., D.V.M., Ph.D., U. of Wisconsin, Madison. Prof., Biomedical Sciences
FitzMaurice, Marnie C., V.M.D., Ph.D., U. of Pennsylvania. Instr., Biomedical Sciences
Fortune, Joanne E., Ph.D., Cornell U. Prof., Biomedical Sciences
Gilmour, Robert F., Ph.D., SUNY Upstate Medical Center. Prof., Biomedical Sciences
Gleed, Robin, BVSc, MRCVS, U. of Liverpool (England). Assoc. Prof., Clinical Sciences
Gunn, Teresa M., Ph.D., U. of British Columbia (Canada). Asst. Prof., Biomedical Sciences
Hermanson, John W., M.S., Ph.D., U. of Florida Gainesville. Assoc. Prof., Biomedical Sciences
Houpt, Katherine A., V.M.D., Ph.D., U. of Pennsylvania. Prof., Clinical Sciences
Kotlikoff, Michael I., Ph.D., U. of California, Davis. Prof., Biomedical Sciences
Lin, David, Ph.D., U. of California, Berkeley. Asst. Prof., Biomedical Sciences
Loew, Ellis R., Ph.D., U. of California, Los Angeles. Prof., Biomedical Sciences
Lorr, Nancy, Ph.D., U. of Oregon. Lec., Biomedical Sciences
Ludders, John, D.V.M., Washington State U. Prof., Clinical Sciences
Maza, Paul, D.V.M., U. of St. Kitts (West Indies). Lec., Biomedical Sciences
McDonough, Sean, D.V.M., Ph.D., U. of Pennsylvania. Assoc. Prof., Biomedical Sciences
Meyers-Wallen, Vicki, V.M.D., Ph.D., U. of Pennsylvania. Assoc. Prof., Biomedical Sciences
Minor, Ronald. V.M.D., Ph.D., U. of Pennsylvania. Prof., Biomedical Sciences
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Njaa, Bradley, L., D.V.M., MVSc, U. of Saskatchewan. Asst. Prof., Biomedical Sciences
Noden, Drew M., Ph.D., Washington U. (St. Louis). Prof., Biomedical Sciences
O'Brian, Timothy, Ph.D., U. of Illinois. Prof., Biomedical Sciences
Oswald, Robert, Ph.D., Vanderbilt U. Prof., Molecular Medicine
Quaroni, Andrea, Ph.D., U. of Pavia (Italy). Prof., Biomedical Sciences
Rawson, Richard E., D.V.M., Ph.D., U. of Minnesota. Sr. Lec., Biomedical Sciences
Roberson, Mark, Ph.D., U. of Nebraska. Prof., Biomedical Sciences
Schimenti, John, Ph.D., U. of Cincinnati. Prof., Biomedical Sciences
Schlafer, Donald H., D.V.M., Ph.D., U. of Georgia. Prof., Biomedical Sciences
Shepard, Laura, D.V.M., Cornell U. Instr., Biomedical Sciences
Suarez, Susan, Ph.D., U. of Virginia. Prof., Biomedical Sciences
Summers, Brian, B.V.Sc., Ph.D., Prof., Biomedical Sciences
Travis, Alexander J., V.M.D., Ph.D., U. of Pennsylvania. Asst. Prof., Biomedical Sciences
Weiss, Robert S., Ph.D., Baylor Coll. of Medicine. Asst. Prof., Biomedical Sciences
Wootton, John F., M.S., Ph.D., Cornell U. Prof., Biomedical Sciences
Xin, Hong-Bo, Ph.D., Beijing Medical U. (People's Republic of China). Asst. Prof., Biomedical Sciences
Yen, Andrew, Ph.D., Cornell U. Prof., Pathology and Director, Graduate Studies in Environmental Toxicology, Biomedical Sciences

College of Engineering

Joint Appointees

Cisne, John L., Assoc. Prof., Geological Sciences/Biological Sciences
Webb, Watt W., Prof., Applied and Engineering Physics/Biological Sciences

Biological Sciences

Joint Appointees

Snedeker, Suzanne M., Asst. Prof., Center for the Environment/Biological Sciences

Division of Nutritional Sciences

Joint Appointees

Arion, William J., Prof., Nutritional Sciences/ Molecular Biology and Genetics
Bensadoun, Andre, Prof., Nutritional Sciences/ Physiology
Kazarinoff, Michael N., Assoc. Prof., Nutritional Sciences/Molecular Biology and Genetics
Wright, Lemuel D., Prof. Emeritus, Nutritional Sciences/Molecular Biology and Genetics

*Joint appointment with College of Arts and Sciences

†Joint appointment with College of Veterinary Medicine

‡Joint appointment with College of Agriculture and Life Sciences

§Joint appointment with College of Engineering